THURSDAY, FEBRUARY 7, 1878

THE SOCIETY OF TELEGRAPH ENGINEERS

WHEN a society which numbered 110 members at the date of its first public meeting can, after an existence of only six years, count 1,000 names upon its books, it has at least justified its existence, and those who have taken the chief part in calling it into being and guiding its course, may fairly consider that the numbers who have sought association with them prove that their proceedings have been, at any rate, not injudicious. It was, therefore, with good reason, that Dr. C. W. Siemens began his address to the Society of Telegraph Engineers on the occasion of his re-election to the office of President, by congratulating the society on the progress made by it since he addressed it in the capacity of its first President on February 28, 1872.

In these congratulations we heartily join, and we think that no one will question the wisdom of the society in calling back to the Presidentship a man who did so much in the early days of its career to prepare the way for the success since realised.

The claim of the Society of Telegraph Engineers to rank as a scientific institution cannot, however, be founded upon the mere number of its members, nor even on the scientific eminence of some of the names to be found in the list. Its scientific position must of course be judged of by considering, not how many or who its members are, but what they do in their associated capacity for the advancement of science. Ample materials for forming such an estimate as this are afforded by the six substantial volumes already published of the *Journal* of the Society of Telegraph Engineers. These volumes contain the papers communicated to the Society and reports of discussions at the meetings, and in addition a considerable number of reprints or abstracts of papers published elsewhere, bearing on the objects pursued by the Society. As might be expected in the case of a society founded primarily to promote the advancement, not of abstract science, but of a branch of industrial enterprise, papers of a so-called "practical" kind are the most numerous, and, if we may judge from the reported discussions, papers of this class are those which call forth the most general interest at the Society's meetings. But even among such papers, embodying as they usually do the results of careful observation and long experience on the matters of which they treat, there are few from which the student of physics may not gather some hint of value. There are, however, a considerable number of papers of which the scientific bearing is more direct. These are papers which, dealing with questions arising primarily out of the practice of the telegraph engineer, treat the problems discussed from the point of view afforded by the general scientific principles applicable to them, or which contain results of no less scientific than practical value. Among papers of this class, one by Mr. Hockin (vol. v. pp. 432-459) on "The Magnitude of Signals received through a Submarine Cable with various Connections at each end, and the best Resistance for the Recording Instrument," is specially deserving of mention. It contains a very masterly treatment of what is in reality a purely scientific problem, though one which has very direct practical importance. And here we may digress for a little in order to point out that this paper of Mr. Hockin's affords an instructive illustration of the mutual beneficial interaction between "theory" and "practice" of which the whole history of the electric telegraph is full. The telegraph is in a fuller degree than most practical inventions the direct outcome of scientific investigation, but when, in the progress of telegraphic enterprise, the project arose of laying long submarine lines, it was found that, though the general nature of the electrical difficulties to be encountered was known, yet the scientific knowledge of the time was not sufficient to indicate clearly the way in which they were to be overcome, and from the nature of the case but little help was forthcoming from empirical experience. The matter was in this state when Sir William Thomson took up the question of the transmission of signals through submarine telegraph cables, and showed how the practical message-carrying power of an insulated conductor laid under water is connected with the dimensions and certain definite electrical qualities of the conductor and its insulating coating. The conclusions which he arrived at mathematically as long ago as 1855 have since remained the foundation of all successful practice in the manufacture of telegraph cables. Sir W. Thomson, however, took account only of the properties of the cable itself, whereas in the actual working of submarine telegraphy very much depends upon the proper selection and arrangement and adaptation to each particular cable of the sending and receiving apparatus employed at the two ends; and what Mr. Hockin has now done is to give a general theory which takes account of the electrical properties of the instruments as well as of the cable. Returning to the *Journal* of the Society of Telegraph Engineers, we may mention a short paper by Mr. Sabine on the Capacity of Accumulators Variously Combined, one by Sir William Thomson on the Comparison of Electrostatic Capacities, and a note by Prof. Maxwell on the Theory of Lightning Conductors, among the original articles, as well as Messrs. Longridge and Brooks's paper on the Submergence of Telegraph Cables and Mr. Schwendler's on the Theory of Duplex Telegraphy, among the reprints, as examples which afford further proof that the Society, is established for practical objects, is not blind to the aid to be derived in the pursuit of those objects from the study of scientific principles. And although we do not suppose that all the 1,000 members study such papers as we have referred to with great eagerness, yet the mere fact of their circulation must do something to convince the most arrogantly "practical" man among them that ignorance is not in all respects a ground for thankfulness.

So far this flourishing society has professedly occupied itself only with telegraphy, but there are not wanting signs either in the Journal or in Dr. Siemens's address, of the difficulty of separating telegraphy from other departments of what may be called applied electricity. Thus, more than one paper has been read to the society upon the application of electricity to firing mines and torpedoes, an operation which, when successfully performed, generally results in causing the persons affected to dispense permanently with telegraphic communication, and Dr. Siemens devotes nearly a quarter of his address

to discussing the application of electricity for illuminating purposes, to the transmission of motive power, and in metallurgic processes. Recent improvements in the means of obtaining powerful electric currents seem to open up a prospect of such applications as those just mentioned, assuming in the near future greater practical importance than they have hitherto possessed, and it does not seem unlikely that, whether or not they think fit to assume the wider designation, the Society of Telegraph Engineers will have become a Society of Electrical Engineers.

G. C. F.

TAIT'S "THERMODYNAMICS" [1]

II.

Sketch of Thermodynamics. By P. G. Tait, M.A., formerly Fellow of St. Peter's College, Cambridge, Professor of Natural Philosophy in the University of Edinburgh. Second Edition, revised and extended. (Edinburgh: David Douglas, 1877.)

PROF. CLAUSIUS is himself the principal founder of the kinetic theory of gases. The theory of the exchanges of the energy of collections of molecules was afterwards developed by Boltzmann to a much greater extent than had been done by Clausius, and it appears from his investigations that whether we suppose the molecules to be acted on by forces towards fixed centres or not, the condition of equilibrium of exchange of energy, or in other words the condition of equality of temperature of two bodies, is that the average kinetic energy of translation of a single molecule is the same in both bodies.

We may therefore define the temperature of a body as the average kinetic energy of translation of one of its molecules multiplied into a constant which is the same for all bodies. If we also define the total heat of the body as the sum of the whole kinetic energy of its molecules, then the total heat must be equal to the temperature multiplied into the number of molecules, and by the ratio of the whole kinetic energy to the energy of translation, and divided by the above constant.

The kinetic theory of gases has therefore a great deal to say about what Rankine and Clausius call the actual heat of a body, and if we suppose that molecules never coalesce or split up, but remain constant in number, then we may also assert, all experiments notwithstanding, that the real capacity for heat (as defined by Clausius) is constant for the same substance in all conditions.

Rankine, indeed, probably biased by the results of experiments, allowed that the real specific heat of a substance might be different in different states of aggregation, but Clausius has clearly shown that this admission is illogical, and that if we admit any such changes, we had better give up real specific heat altogether.

Statements of this kind have their legitimate place in molecular science, where it is essential to specify the dynamical condition of the system, and to distinguish the kinetic energy of the molecules from the potential energy of their configuration; but they have no place in thermodynamics proper, in which we deal only with sensible masses and their sensible motions.

Both Rankine and Clausius have pointed out the importance of a certain function, the increase or diminution of which indicates whether heat is entering or leaving the body. Rankine calls it the thermodynamic function, and Clausius the entropy. Clausius, however, besides inventing the most convenient name for this function, has made the most valuable developments of the idea of entropy, and in particular has established the most important theorem in the whole science,—that when heat passes from one body to another at a lower temperature, there is always an increase of the sum of the entropy of the two bodies, from which it follows that the entropy of the universe must always be increasing.

He has also shown that if the energy of a body is expressed as a function of the volume and the entropy, then its pressure (with sign reversed) and its temperature are the differential coefficients of the energy with respect to the volume and the entropy respectively, thus indicating the symmetrical relations of the five principal quantities in thermodynamics.

But Clausius, having begun by breaking up the energy of the body into its thermal and ergonal content, has gone on to break up its entropy into the transformational value of its thermal content and the disgregation.

Thus both the energy and the entropy, two quantities capable of direct measurement, are broken up into four quantities, all of them quite beyond the reach of experiment, and all this is owing to the actual heat which Clausius, after getting rid of the latent heat, suffered to remain in the body.

Sir William Thomson, the last but not the least of the three great founders, does not even consecrate a symbol to denote the entropy, but he was the first to clearly define the intrinsic energy of a body, and to him alone are due the ideas and the definitions of the available energy and the dissipation of energy. He has always been most careful to point out the exact extent of the assumptions and experimental observations on which each of his statements is based, and he avoids the introduction of quantities which are not capable of experimental measurement. It is therefore greatly to be regretted that his memoirs on the dynamical theory of heat have not been collected and reprinted in an accessible form, and completed by a formal treatise, in which his method of building up the science should be exhibited in the light of his present knowledge.

The touchstone of a treatise on thermodynamics is what is called the second law.

Rankine, as we have seen, founds it on statements which may or may not be true, but which cannot be considered as established in the present state of science.

The second law is introduced by Clausius and Thomson as an axiom on which to found Carnot's theorem that the efficiency of a reversible engine is at least as great as that of any other engine working between the same limits of temperature.

If an engine of greater efficiency exists, then, by coupling this engine with Carnot's engine reversed, it is possible to restore to the hot body as much heat as is taken from it, and at the same time to do a certain amount of work.

If with Carnot we suppose heat to be a substance, then this work would be performed in direct violation of the first law—the principle of the conservation of energy. But if we regard heat as a form of energy, we cannot apply

[1] Continued from p. 259.

this method of *reductio ad absurdum*, for the work may be derived from the heat taken from the colder body.

Clausius supposes all the work gained by the first engine to be expended in driving the second. There is then no loss or gain of heat on the whole, but heat is taken from the cold body, and an equal quantity communicated to the hot body, and this process might be carried on to an indefinite extent.

In order to assert the impossibility of such a process in a form of words having sufficient verisimilitude to be received as an axiom, Clausius, in his first memoir, simply says that this process "contradicts the general deportment of heat, which everywhere exhibits the tendency to equalise differences of temperature, and therefore to pass from the warmer to the colder body."[1]

In its obvious and strict sense no axiom can be more irrefragable. Even in the hypothetical process, the impossibility of which it was intended to assert, every communication of heat is from a warmer to a colder body. When the heat is taken from the cold body it flows into the working substance which is at that time still colder. The working substance afterwards becomes hot, not by communication of heat to it, but by change of volume, and when it communicates heat to the hot body it is itself still hotter.

It is therefore hardly correct to assert that heat has been transmitted or transferred from the colder to the hotter body. There is undoubtedly a transfer of energy, but in what form this energy existed during its middle passage is a question for molecular science, not for pure thermodynamics.

In a note added in 1864 Clausius states the principle in a modified form, "that heat cannot of itself pass from a colder to a warmer body"[1] and finally, in the new edition of his "Theory of Heat" (1876) he substitutes for the words "of itself" the expression "without compensation."[2]

With respect to the first of these emendations we must remember that the words "of itself" are not intended to exclude the intervention of any kind of self-acting machinery, and it is easy, by means of an engine which takes in heat from a body at 200° C., and gives it out at 100° to drive a freezing machine so as to take heat from water at 0°, and so freeze it, and also a friction break so as to generate heat in a body at 500°. It would therefore be necessary to exclude all bodies except the hot body, the cold body, and the working substance, in order to exclude exceptions to the principle.

By the introduction of the second expression, "without compensation," combined with a full interpretation of this phrase, the statement of the principle becomes complete and exact; but in order to understand it we must have a previous knowledge of the theory of transformation-equivalents, or in other words of entropy, and it is to be feared that we shall have to be taught thermodynamics for several generations before we can expect beginners to receive as axiomatic the theory of entropy.

Thomson, in his "Third Paper on the Dynamical Theory of Heat" (*Trans.* R.S. Edin., xx., p. 265 (read March 17, 1851) has stated the axiom as follows:—

"It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of surrounding objects."

Without some further restriction this axiom cannot be considered as true, for by allowing air to expand we may derive mechanical effect from it by cooling it below the temperature of the coldest of surrounding objects.

If we make it a condition that the material agency is to be left in the same state at the end of the process as it was at first, and also that the mechanical effect is not to be derived from the pressure of the hot or of the cold body, the axiom will be rendered strictly true, but this brings us back to a simple re-assertion of Carnot's principle, except that it is extended from heat engines to all other kinds of inanimate material agency.

It is probably impossible to reduce the second law of thermodynamics to a form as axiomatic as that of the first law, for we have reason to believe that though true, its truth is not of the same order as that of the first law.

The first law is an extension to the theory of heat of the principle of conservation of energy, which can be proved mathematically true if real bodies consist of matter "as per definition," acted on by forces having potentials.

The second law relates to that kind of communication of energy which we call the transfer of heat as distinguished from another kind of communication of energy which we call work. According to the molecular theory the only difference between these two kinds of communication of energy is that the motions and displacements which are concerned in the communication of heat are those of molecules, and are so numerous, so small individually, and so irregular in their distribution, that they quite escape all our methods of observation; whereas when the motions and displacements are those of visible bodies consisting of great numbers of molecules moving all together, the communication of energy is called work.

Hence we have only to suppose our senses sharpened to such a degree that we could trace the motions of molecules as easily as we now trace those of large bodies, and the distinction between work and heat would vanish, for the communication of heat would be seen to be a communication of energy of the same kind as that which we call work.

The second law must either be founded on our actual experience in dealing with real bodies of sensible magnitude, or else deduced from the molecular theory of these bodies, on the hypothesis that the behaviour of bodies consisting of millions of molecules may be deduced from the theory of the encounters of pairs of molecules, by supposing the relative frequency of different kinds encounters to be distributed according to the laws of probability.

The truth of the second law is therefore a statistical, not a mathematical, truth, for it depends on the fact that the bodies we deal with consist of millions of molecules, and that we never can get hold of single molecules.

Sir William Thomson[1] has shown how to calculate the

[1] Und das widerspricht dem sonstigen Verhalten der Wärme, indem sie überall das Bestreben zeigt, vorkommende Temperaturdifferenzen auszugleichen und also aus den wärmeren Körpern in die kälteren überzugehen.

[2] Dass die Wärme nicht von selbst aus einem kälteren in einem wärmeren Körper übergehen kann.

[3] Ein Wärmeübergang aus einem kälteren in einem wärmeren Körper kann nicht ohne Compensation stattfinden.

[1] "On the Kinetic Theory of the Dissipation of Energy," *Proc.* R.S. Edin., February 16, 1874, vol. viii. p. 323, also in NATURE, vol. ix. p. 441.

probability of the occurrence within a given time of a given amount of deviation from the most probable distribution of a finite number of molecules of two different kinds in a vessel, and has given a numerical example of a particular case of the diffusion of gases.

The same method might be extended to the diffusion of heat by conduction, and the diffusion of motion by internal friction, which are also processes by which energy is dissipated in consequence of the motions and encounters of the molecules of the system.

The tendency of these motions and encounters is in general towards a definite state, in which there is an equilibrium of exchanges of the molecules and their momenta and energies between the different parts of the system.

If we restrict our attention to any one molecule of the system, we shall find its motion changing at every encounter in a most irregular manner.

If we go on to consider a finite number of molecules, even if the system to which they belong contains an infinite number, the average properties of this group, though subject to smaller variations than those of a single molecule, are still every now and then deviating very considerably from the theoretical mean of the whole system, because the molecules which form the group do not submit their procedure as individuals to the laws which prescribe the behaviour of the average or mean molecule.

Hence the second law of thermodynamics is continually being violated, and that to a considerable extent, in any sufficiently small group of molecules belonging to a real body. As the number of molecules in the group is increased, the deviations from the mean of the whole become smaller and less frequent; and when the number is increased till the group includes a sensible portion of the body, the probability of a measurable variation from the mean occurring in a finite number of years becomes so small that it may be regarded as practically an impossibility.

This calculation belongs of course to molecular theory and not to pure thermodynamics, but it shows that we have reason for believing the truth of the second law to be of the nature of a strong probability, which, though it falls short of certainty by less than any assignable quantity, is not an absolute certainty.

Several attempts have been made to deduce the second law from purely dynamical principles, such as Hamilton's principle, and without the introduction of any element of probability. If we are right in what has been said above, no deduction of this kind, however apparently satisfactory, can be a sufficient explanation of the second law. Indeed some of them have already indicated their unsoundness by leading to determinations of physical quantities which have no existence, such as the periodic time of the alternations of the volume of particular gases.[1]

J. CLERK MAXWELL

OUR BOOK SHELF

Heroes of North African Discovery. By N. D'Anvers. (London: Marcus Ward and Co., 1877.)

MR. D'ANVERS has here made an interesting *résumé* of the work of the principal travellers who have made Africa known to the world. He briefly dismisses the earlier explorers, the bulk of the volume being devoted to those of the eighteenth and nineteenth centuries. Mr. D'Anvers has evidently read his authorities carefully, and gives a clear account of his heroes' adventures, and of the main results achieved. The book is evidently meant for young readers, and to them both the text and the numerous illustrations will prove attractive. But all who wish to have a fair knowledge of what has been hitherto achieved in the field of African discovery should read this interesting and instructive volume. The author prefixes a list of the authorities he has consulted, and promises another volume on South Africa, in which the results obtained by Mr. Stanley will be embodied.

Manual of Agriculture; including the Application thereto of Chemistry, Geology, Botany, Animal Physiology, and Meteorology. By Richard Henderson.

THIS is a reprint of one of the Highland Agricultural Society's prize essays. It forms a very marked exception from the thoroughly practical essays which are usually published by that society, so much so indeed, that it is a source of regret that a society which has done so much to improve agricultural education, should have in any way stamped the present work with its approval and authority.

The work is divided into seven chapters, of which five are devoted to some notices of chemistry, geology, botany, animal physiology, and meteorology, and the seventh alone treats upon the application of these sciences to agricultural practice, which is the professed subject of the work.

A few extracts from the first six chapters will given an idea of the character of this part of the work. The second chapter deals with chemistry, and is largely made up of comments upon eighteen elements, the descriptions being remarkably similar to those given by Roscoe in his "Lessons." It is fair to say that the author occasionally introduces original remarks, as, for instance, in saying that "carbon forms about fifty per cent. of the residue of plant-life when the latter is charred, and access of atmospheric air or oxygen prevented, for oxidised carbon escapes as a gas." Prof. Roscoe fares rather badly at the hands of our author, since he in another place says, "Roscoe gives the following graphic formula as the average composition of blood," and he appends the average percentage composition.

We are told again that at the sea-level the pressure of the air "can support a column of mercury thirty inches high in a tube *in vacuo*." Concerning fogs and mists, "they result from the radiation of heat from land and water, taking with it aqueous vapour, which becomes visible upon encountering cooler air. Similarly rain is produced when heated volumes of air are deprived of their heat, through the fall of condensed vapour, which assumes, according to the temperature it encounters, the form of hail, rain, or snow."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Sun-Spots and Terrestrial Magnetism

MR. B. G. JENKINS, in his letter to NATURE, vol. xvii. p. 260, says, "I have ventured to state my belief that we are now passing through a long minimum period, one very similar to that which occurred at the close of last century." It was the chief object of

[1] Szily, *Phil. Mag.*, October, 1876; Clausius, *Pogg. Ann.*, cxlii., p. 433; *Pogg. Ann.*, cxlvi., p. 585, May, 1872; J. J. Müller, *Pogg. Ann.*, cliii., p. 10

my communication to NATURE, vol. xvii. p. 183, to show the latter fact as far as the observations go up to the present time. I did not, however, venture in that article to make a guess as to the future, which really could have little weight till we have another year's observations. Yet I thought it desirable, nearly two months ago, to place in the hands of Prof. Balfour Stewart the evidence that the possibility of such an event, as an obvious conclusion from my results, had not escaped me. As Mr. Jenkins has published his guess, I may do the same with mine. The latter differs, however, from his in a very important way. He supposes the next maximum will be in 1887, whereas I suppose that the weak maximum of 1797 may be repeated near 1880. In this latter case the interval between the two will be nearly double that found by me (forty-two years), during which the sun-spot period appears to have all its different lengths.

February 1 JOHN ALLAN BROUN

Terrestrial Magnetism

I HEREWITH submit a notice of an experiment for illustrating to a class the action of terrestrial magnetism. In a simple way it clearly exhibits to a large audience the action of the currents of electricity that pass around the earth. The experiment was suggested on reading a paper by Prof. J. W. Mallet, F.R.S., of the University of Virginia, on "The Apparent Alteration in Weight of a Wire placed East and West, and Traversed by an Electric Current" (*Phil. Mag.*, November, 1877).

Instead of disconnecting the wires placed east and west from the portion of the rectangle, as was done by Prof. Mallet in the experiment alluded to, whereby the attractive or repulsive action of the earth currents on one side only of the rectangle was obtained, it occurred to me to suspend the whole rectangle to a balance. Properly arranged in this way the attraction for parallel currents in same direction, and repulsion for currents in opposite direction would generate a couple, tending to produce rotation around an east and west horizontal axis, and hence augment the deflection of the balance.

A rectangular frame was made of light poplar wood, of section three by two centimetres, whose sides were one metre in length by three-fourths of a metre in breadth. About the perimeter of this rectangle there were wrapped twenty coils of insulated copper wire. Each extremity of the wire was made to terminate near the centre of one of the shorter sides, and passing through the wooden frame, was fastened and cut off about 3 c.m. from the frame.

This rectangular frame was then so suspended, in a horizontal position, by wires attached to the pans of an ordinary Delenil's hydrostatic balance, that the longer sides were at right-angles to the beam. By adjusting weights in the scale pans the index of the balance was brought to the zero. Two small orifices bored in a block of wood a centimetre apart, served as mercury cups, in which the extremities of the short terminal wires were immersed; near the bottom and through the walls of these wooden mercury-cups were screened small brass hooks, which served as connectors, to which the wires of the battery were attached. The balance was now so placed that the longer sides of the suspended rectangle were *at right-angles with the magnetic meridian*, or in the *magnetic* east and west line.

When the current from the battery was made to pass around the rectangle from east to west, on the northern side, and from west to east, on the southern side, by the theory of terrestrial magnetism, the north side of the rectangle would be attracted to the earth, and the south side repelled, and that this was so the corresponding deflection of the balance rendered plainly visible. When the current was reversed the deflection was in the opposite direction. By breaking and closing the circuit at proper intervals to augment the oscillations, the large frame was readily made to oscillate through an arc of 5°. When the sides of the rectangle were placed north-east and south-west, the current produced no sensible effect. A bichromate of potash battery of sixteen cells was used with plates of zinc and carbon 25 cm. by 6 cm.

With a rectangle containing a larger number of coils of wire attached to a delicate balance by the use of a *constant* battery, the variations in the earth's magnetism might be thus observed.

WM. LEROY BROUN

Vanderbilt University, Nashville, Tenn., January 11

Seiches and Earthquakes

IN the last number of NATURE (p. 234) you make an allusion to the fact that the earthquake of October 8, 1877, has not been traced by the self-registering "limnimeters" (tide-gauge) of M. Ph. Plantamour at Geneva, and myself at Morges. Let me take the opportunity of the great publicity of your excellent paper to ask the naturalists who live in other countries more frequently visited by earthquakes, for an explanation.

I believe I have demonstrated in many different papers that the phenomenon called *seiches*, which consists in rhythmical movements of the level of the lake, is a balancing-wave, a wave of stationary uninodal oscillation. The water moves in balancing oscillation in the two principal diameters of the lake, in the direction of the greatest length and of the greatest breadth. For setting the water in such an oscillatory movement there are two possible causes:—

1. A shock given to the water itself is the most frequent case, and I can prove that generally the *seiches* are caused by some rupture of the equilibrium of the atmospheric pressure; many storms, and especially those that fall somewhat abruptly on the lake, are accompanied by very high *seiches*, and I have many examples of the beginning of the oscillatory movement of the water exactly at the same time the storm commences.

2. A movement of the soil on which the water lies, an earthquake. It is evident that a shock given to a basin can put the water in oscillatory movement. In fact, it happens frequently. I will only recall the colossal transmission-waves in the Pacific Ocean on August 13, 1868, after the earthquake of Arica; that of May 9, 1877, at Iquique; and in earlier times, the earthquakes at Messina, 1783; at Port-Royal (Jamaica), 1692; at Callao, 1586, &c. If such enormous waves had taken place in a closed basin, as our lakes, it would probably have brought about an oscillatory movement of *seiches*. I could bring many facts to prove it; only one example, the earthquake of Lisbon (1755), was noticed in Switzerland and Germany, chiefly by the movements of the water of the lakes; the description of these movements recalls perfectly the *seiches*.

It is also theoretically probable that the shock given to the ground extends to the waters, and that an earthquake will produce *seiches* in a lake. Unfortunately the facts observed up to this time do not confirm this theoretical view. Since I established at Morges a self-registering limnimeter of the greatest sensitiveness, in March, 1876, six different earthquakes have been noticed in our country, and specially three earthquakes were felt at Morges itself—May 7 and November 29, 1876, and October 8, 1877. Not one of those six earthquakes has been traced by the self-registering limnimeter; not one has interrupted the rhythmic oscillation of the *seiches* which were taking place; not the smallest alteration of the curve has shown that the water had been acted upon in a peculiar manner; neither was the limnimeter of M. Ph. Plantamour, which was at work during the earthquake of October 8, 1877, influenced by that very severe shock. And yet our apparatus are extremely sensitive; when the lake is sufficiently calm my limnimeter can show the waves originated by a steamboat which passes 10–15 kilometres off the apparatus, or it registers the waves caused by a steamer which has passed by my observatory two or three hours before.

How can these contradictory facts be explained? On one hand, the earthquakes cause in many places enormous waves; on the other, three earthquakes strong enough to have awakened men out of their sleep, have not put in movement the most sensitive, always working, self-registering apparatus.

I suppose that the shocks of the earth do not transfer always the movement to the water; that only in a special direction of the shock a special intensity, a special duration, the water itself is put in movement and takes the rhythmic oscillation of the *seiches*. If I shake a basin the water is not always and necessarily put in oscillatory movement. I think it is the same for the *seiches*, and I believe that only certain movements of the earth cause the water of the lakes to move.

It is the point on which I seek an answer from naturalists who have more opportunity to observe the effects of earthquakes. I ask if each earthquake is accompanied by waves of the sea; if each shock of the same intensity is accompanied by waves of the same amplitude; if there are not differences between the different earthquakes; if some have the enormous waves of Iquique or Arica; if others are without those waves?

I should be very thankful to receive an answer to the above questions. F. A. FOREL

Morges, Switzerland, January 24

Electrical Experiment

A FRIEND of mine has called my attention to a letter of F. T. Pirani, of Melbourne, accompanied by some remarks of Prof. J. C. Maxwell, in NATURE, vol. xvii. p. 180.

Mr. Pirani concludes his letter with the words, "If the phenomenon (described in the letter) has not been noticed before, I shall be obliged to you if you will kindly communicate it to NATURE."

I take the liberty to request you to call, by means of your esteemed journal, the attention of the author to an article of mine, published in the late Prof. Poggendorff's *Annalen der Physik* (vol. clvii., 1876), an abstract of which appeared in the *Philosophical Magazine* (5 ser. vol. i.). The phenomenon alluded to in Mr. Pirani's letter, *i.e.* the existence of an electromotive force due to gravity, in a vertical column of an electrolyte, is, I believe, fully proved by the experiments described in the article. The same difficulties met with by Mr. Pirani and Prof. Maxwell, who repeated the experiment, that is, the presence of irregular, casual currents, due to bubbles of air, &c., have also been encountered by me; I intimate the means of getting rid, to a certain extent, of this influence.

The transport of metal in one direction being accompanied by a transport of the other ion in the opposite direction, the phenomenon is more complete than it might appear at first sight, and the electromotive force changes its sign according to the electrolyte employed. R. COLLEY

Kasan, Russia, January 23

Oriental Affinities in the Ethiopian Insect-Fauna

MANY naturalists have already drawn attention to the Indian affinities in the African fauna; in other words, the zoological relationship between the Oriental and Ethiopian regions. The late Dr. Stoliczka has pointed this out in the Malayan ornithology; Mr. Wallace has described the same thing in the mammalia and birds of West Africa, these possessing "a special Oriental or even Malayan element." He has also drawn attention to the Oriental element in the Ethiopian reptiles and amphibia, and to the many cases of the same in the South African fauna. Mr. Blandford has treated of the "African element in the fauna of India," more particularly as regards the mammalia; and the late Mr. Blyth has shown the ancient date of this relationship from the evidence afforded by the Siwâlik deposits. Mr. Murray has even inclined to the opinion that the Indo-Malayan region should be included with that of Africa, south of the Sahara.

The "Insecta" of the Ethiopian region also shows the same Oriental relationship, which seems to have hitherto received less attention. Dr. Stoliczka has described this in the "Indian Arachnoidea," and Mr. A. Murray in the coleoptera of which he has given the names of eleven genera common to the two regions.

The same thing may be seen in the Lepidoptera and Hemiptera, of which I can only treat briefly, hoping to deal with the subject in a more exhaustive and analytical form when possessed of adequate data, which at present do not exist.

Of the Lepidoptera a few specific examples will perhaps serve the purpose better than the names of the many genera that could be adduced. In the Rhopalocera:—*Danais chrysippus*, *Melanitis leda*, *Atella phalanta*, *Hypanis ilithyia*, *Lycæna telicanus*, *Idmais phisadia*, and *Callosune danæ*, all belong to the two regions, and with the exception of *C. danæ* and *I. phisadia*, have been all recorded from Madagascar. However, *D. chrysippus* (Greece and Turkey), *H. ilithyia* (Nubia, Abyssinia, and Arabia), and *L. telicanus* (Egypt and Arabia), would seem to show from those habitats their route of migration from one region to the other. In the Heterocera two examples must suffice, and may be accepted as typical of what probably occurs to a far greater extent among the large number of African moths still unknown to science. *Plusia verticillata* and *Patula macrops* have a wide range over the two areas.

In the African Hemiptera-Heteroptera the Oriental relationship is very pronounced. The following are some of the genera common to the two regions:—*Solenosthedium*, *Hotea*, *Coptosoma*, *Brachyplatys*, *Plataspis*, *Canthecona*, *Agonoscelis*, *Antestia*, *Bathycœlia*, *Catacanthus*, *Tesseratoma*, *Aspongopus*, *Phyllocephala*, *Macrina*, *Mictis*, *Leptoglossus*, *Odontopus*, *Physopelta*, *Lestomerus*, *Catamiarus*, *Pachynomus*, *Acanthaspis*, *Oncocephalus*, and *Thodelmus*. Genera, of course, are subject to constant revision and redivision, making, as a rule, generic calculations of geographical distribution very uncertain and unstable. A genus of to-day may embrace species belonging to two regions; to-morrow an author may split this genus into two, for which he may find local characters. In other words, genera common to two regions at the present time may be shown as the contrary by a later worker. In a general way the value of the term genus is often equal to the value of the term species. The twenty-four genera of Hemiptera, however, which I have enumerated above, may be accepted as more certain examples. Dr. Stâl has paid particular attention to this order, and has made many genera from a minute examination of structure, and I think his divisions must at least be considered as sufficiently exhaustive. I have carefully compared my list with his latest classification, and find that eighteen out of the twenty-four genera still remain intact on his catalogue, one other is common to the two regions from an East African species I recently described, and so only five remain, which Dr. Stâl has further subdivided. Of these twenty-four genera, *twenty-two extend to the West African subregion*, twelve have at the present time also been recorded from China, and twelve from the Australian region. When we further analyse the list as to the probable route of migration, it is found that eight genera appear in Madagascar and two in Réunion; whilst a northern junction is also indicated by one genus being found in Tangier and Syria, two in Egypt, and one in Abyssinia. A few species are common to the two regions, as *Leptoglossus membrananceus*, *Oncocephalus annulipes*, &c.

It is probable that the African Neuroptera and Orthoptera may show the same affinities. W. L. DISTANT

Derwent Grove, East Dulwich

Sense in Insects—Drowned by a Devil-Fish

In the file of NATURE from October 18 to the end of November which I have just received, I find a discussion regarding the senses possessed by insects, especially the lepidoptera. For years I have been in the habit of collecting these insects for my friends, and of course have become more or less acquainted with their habits. I recall one or two instances in point. In Costa Rica the Heliconias frequent certain flowers, and pass over others of the same colour and same approximate size without noticing them. But the most marked case was of the large brilliant Morphos. My Indian servants always carried with them a fermented paste of maize flour, which they mixed with water to the consistency of gruel as a beverage. On our arriving at the side of a stream in a narrow gorge, invariably, within a few minutes after they opened a package of this paste, although there might not have been a butterfly in sight before, those most brilliant of their kind would come sailing up, always from leeward, and I have made some of my best catches in this manner. I have also caught them by baiting with a piece of over-ripe or even rotting banana. At other times they were almost unapproachable. They seem to live on fruits just merging into the state of rottenness.

I have never been able to detect any sensitiveness to sound in insects, and suspect that the case cited by one of your correspondents might be equally explained by sight, or by the vibration of the air caused by striking the glass. That certain coleoptera and diptera are attracted by smell alone is too obvious to require proof.

The same may be said of ants in following an established trail. I have experimented with this frequently, obliterating the scent for a space of but a few inches; and watching the puzzled wanderers each going an inch or less beyond his predecessor, hunting the lost clue until the blank was finally bridged over. After that if the new route as re-opened differed from the old, it was nevertheless rigidly followed even if longer and less direct.

Another matter. You mention a case of "drowning by a devil-fish" (NATURE, vol. xvii. p. 27). The story is to me very probable. I once measured a specimen of my *Octopus punctatus* caught in San Francisco harbour, which gave clear 15 feet from point to point of the arms. The animal, as I bought it from a fisherman, filled a champagne basket. W. M. GABB

Puerto Plata, Sto. Domingo, December 29, 1877

Drowned by a Devil Fish

THOUGH in British Columbia at the time of the occurrence of the incident referred to by Mr. Moseley in NATURE (vol. xvii. p. 27) I was in the interior, and consequently heard nothing of the matter. On reading Mr. Moseley's letter, however, I wrote

to my friend Dr. W. F. Tolmie, of Victoria, and have just received from him an account verifying in all essential particulars the extract quoted by Mr. Moseley from the *Weekly Oregonian*.

A party of Makaw or Makah Indians of Cape Flattery were returning from a visit to the Songish Indians of the vicinity of Victoria, and camped the first afternoon at Metchosin, on the south shore of Vancouver Island. A young woman having separated herself from the others to bathe, did not return in the evening, and after having searched for her in vain the next morning, the rest of the party were about to continue on their journey, when, on rounding the first point, they saw the body of the woman as if seated on the sandy sea-bottom, with a large octopus attached to it, which, according to the description of Dr. Tolmie's informant, resembled a "fifty-pound flour sack, full." The body was rescued in the manner described in the *Oregonian*, and when brought ashore, still had portions of the arms of the octopus adhering to it.

Dr. Tolmie also mentions the case of an Indian woman at Fort Simpson, who had, many years ago, a narrow escape from a similar death; also that among the Chimsyan Indians traditions of escapes and occasional cases of drowning exist, and further, that among these people a story is current that "A two-masted vessel manned in part or whole by men with obliquely placed eyes and wearing queues (at Milbank Sound, lat. 52°, about seventy years ago) was seized by an enormous squid, whose tentacles had to be chopped with axes ere the craft was clear of it. The ship is said to have been wrecked further south on the coast, in consequence of the evil influence of the monster."

GEORGE M. DAWSON

Geological Survey of Canada, Montreal, January 11

Eucalyptus

IN NATURE, vol. xvii. p. 10, Mr. A. Nicols says he has seen attacks of fever come on in a forest of Eucalyptus; malaria prevails there, he maintains. Does that malaria, the degree of gravity of which he does not describe, seriously compromise health? That is the question. It is probable, notwithstanding the presence of Eucalyptus, that there are yet numerous cases of fever near Lake Fetzara (Algeria), but really of such small importance as to permit, without serious danger to health, the working of the ground or the mines of these districts.

As to mosquitoes, allow me to recall that there exist very many species of these animals which, apart from their common quality of feeding on and tormenting mammals, and especially man, have origins, habitats, evolutions and habits completely different; some live only in the larval state, others frequent moist ground, and others live always in the larval state, in fungi. In a country which is far from being tropical and marshy, Newfoundland, the pine woods are infested during the short summer by myriads of mosquitoes, which become a real danger for the rash traveller. It will be understood that all these species do not exist at the same time in the same place, and that at Lake Fetzara the marshes are being profoundly modified, or are disappearing, and the mosquitoes, properly called, are also disappearing. Moreover, if there does not exist in the country, as is probable, any species of mosquito living in the shade of the forest, the country will be rid of these animals, a thing which cannot take place in Australia, where there are species living in the forests. In other words, it is not the Eucalyptus which at Fetzara has caused the mosquitoes to disappear, but rather the absence of the conditions necessary to the life and reproduction of mosquitoes, which have become deficient in consequence of the modification of the soil, brought about by the numerous plantations of Eucalyptus.

DR. CALMY

Saigon, December 19, 1877

Explosive Dust

IN NATURE, vol. xvii. p. 123, I noticed a letter by A. Mackennah on an explosion of malt dust in a grinding machine. This I believe to be not an uncommon occurrence, as I hear there have been three explosions in our mill within a period of four years, and these not due to any such culpable carelessness as allowing a naked flame to approach the heated impalpable dust, but ignited either by a spark from a piece of flint passing through the steel rollers (barley from some localities is invariably accompanied by quantities of small fragments of flint), or from excessive friction on some part of the wood fittings.

The following facts I obtained from the man in charge of our mill at the time of the worst of these explosions, about three years ago:—

They were grinding at the ordinary pace about mid-day with the window open and no gas turned on.

The explosion was quite sudden and the flame sufficient to singe the man's whiskers; the force was so great that the door of the engine-room was blown open, though the only opening between the two rooms was a small hole through which the shafting worked.

Having had several holes bored through the wood lining to allow a free current of air, there has been no explosion since.

The danger of fine impalpable coal dust in collieries is too manifest to need argument based on the action of analogous bodies, but still the above facts may interest some of your readers.

F. E. L.

Burton-on-Trent, January 22

Dendritic Gold

WILL one of my fellow-readers of NATURE be good enough to inform me, through its columns, with the name and publisher of such a work on mineralogy (short, if possible) as will give me the best information on the subject of the dendritic gold existing in sandstones in New Zealand, as reported in the *Proceedings* of the Wellington Society (NATURE, vol. xvi. p. 567).

It is my wish specially to know the colour of such dendrites, the geologic age of the rock containing them, and, if possible, to obtain a satisfactory account of their origin, as hitherto I have believed that metals take this form solely by deposition from solution.

I ask this in the interest of friends in South Africa (in addition to the personal desire for knowledge), where, in many parts of the Transvaal, gold "prospects" can be obtained, though usually in quantities unprofitably small, in nearly every case there being no quartz from which it could have been derived; at least so said my informants, old Australians.

Black dendrites I have noticed between the (once) horizontal strata of sandstone boulders in the Kimberley diamond mine, but was unable, at the time, to decide their nature.

R.

DEMONSTRATION OF CURRENTS ORIGINATED BY THE VOICE IN BELL'S TELEPHONE

IF two wires, A and B, be respectively connected with the two binding screws, R and S, of a telephone, and the other ends of the wires be connected with a Thompson's reflecting galvanometer, the following experiments can be made:—

1. On pressing in the iron disc a deflection is produced on the scale, say, from right to left.

2. On reversing the wires so that A is connected with S and B with R, and repeating Experiment 1, a deflection is produced in the opposite direction, *i.e.* from left to right.

3. Shouting or singing produces no deflection.

If a Lippmann's capillary electrometer be substituted for the galvanometer, the following results are obtained:—

4. If Experiments 1 and 2 be repeated, similar movements are observed, *i.e.* in one case the mercury column moves to the point of the capillary tube, in the other away from it.

5. If the gamut be loudly sung up, note by note, to the sound *ah*, one note is found to give a movement of the mercury column, about ten times as great as that observed in Experiment 4, towards the point of the tube. The octaves, especially the higher ones, and some harmonics of this note yield similar results. (It is this note which tetanises a nerve muscle preparation as observed by Fick, &c.)

6. If the wires be reversed and the same note sung, a movement of the mercury column is seen as large as that in Experiment 5, but in the *same* direction. *So that reversing the wires does not alter the direction as indicated by the electrometer.*

7. If the primary wire of a Du Bois Reymond's coil be placed in the circuit of a telephone, and the wires from the secondary circuit coupled with the electrometer, the note mentioned above produces the same movement as in Experiments 5 and 6, when the secondary coil is about

8 cm. from the primary. *Reverse the wires in the secondary circuit, reverse the wires in the primary circuit, how you please, the mercury always moves towards the point of the capillary.*

8. Shouting or singing (excepting the above-mentioned note) produces no visible effect under the conditions mentioned in Experiments 5, 6, and 7.

9. If the secondary coil be now moved close up, so as to cover as completely as possible the primary, talking to the telephone with the ordinary voice, *i.e.* with moderate strength and at any pitch, produces a definite movement of the mercury column for each word, some sounds of course giving more movement than others, *but the movement is always towards the end of the capillary.* Singing the note mentioned in Experiments 5, 6, and 7 loudly, produces a movement too large to be measured with the electrometer.

Reversing the poles of the magnet in the telephone does not alter the results of Experiments 5, 6, 7, and 9.

On mentioning the above results to Dr. Burdon Sanderson, he suggested that the apparently anomalous behaviour of the electrometer might be accounted for, by supposing that the mercury moved *quicker* when a current passed towards the point of the capillary than when it flowed in the opposite direction ; so that if a succession of rapidly alternating currents be passed through the instrument, the mercury will always move towards the point of the capillary, the movement away from the point being masked by the sluggishness of the instrument in that direction. That this explanation is the correct one is proved by the following experiment :—The current from two Grove's cells is sent through a metal reed vibrating 100 times a second, the contact being made and broken at each vibration, the primary wire of a Du Bois Reymond's induction-coil is also included in the circuit ; on connecting the electrometer with the secondary coil placed at an appropriate distance the mercury always moves to the point of the tube whatever be the direction of the current.

F. J. M. PAGE

Physiological Laboratory, University College,
London, February 2

NOTE.—On February 4 Prof. Graham Bell kindly placed at my disposal a telephone much more powerful than any of those I had previously used. On speaking to this instrument, the electrometer being in the circuit, movements of the mercury column as considerable as those in Experiment 9 were observed.—F. J. M. P.

CHEMISTRY AND ALGEBRA

IT may not be wholly without interest to some of the readers of NATURE to be made acquainted with an analogy that has recently forcibly impressed me between branches of human knowledge apparently so dissimilar as modern chemistry and modern algebra. I have found it of great utility in explaining to non-mathematicians the nature of the investigations which algebraists are at present busily at work upon to make out the so-called *Grundformen* or irreducible forms appurtenant to binary quantics taken singly or in systems, and I have also found that it may be used as an instrument of investigation in purely algebraical inquiries. So much is this the case that I hardly ever take up Dr. Frankland's exceedingly valuable "Notes for Chemical Students," which are drawn up exclusively on the basis of Kekulé's exquisite conception of *valence*, without deriving suggestions for new researches in the theory of algebraical forms. I will confine myself to a statement of the grounds of the analogy, referring those who may feel an interest in the subject and are desirous for further information about it to a memoir which I have written upon it for the new *American Journal of Pure and Applied Mathematics*, the first number of which will appear early in February.

The analogy is between atoms and *binary* quantics exclusively.

I compare every binary quantic with a chemical atom. The number of factors (or rays, as they may be regarded by an obvious geometrical interpretation) in a binary quantic is the analogue of the number of *bonds*, or the *valence*, as it is termed, of a chemical atom.

Thus a linear form may be regarded as a monad atom, a quadratic form as a duad, a cubic form as a triad, and so on.

An invariant of a system of binary quantics of various degrees is the analogue of a chemical substance composed of atoms of corresponding *valences*. The order of such invariant in each set of coefficients is the same as the number of atoms of the corresponding *valence* in the chemical compound.

A co-variant is the analogue of an (organic or inorganic) compound radical. The orders in the several sets of coefficients corresponding, as for invariants, to the respective valences of the atoms, the free valence of the compound radical then becomes identical with the degree of the co-variant in the variables.

The weight of an invariant is identical with the number of the bonds in the chemicograph of the analogous chemical substance, and the weight of the leading term (or basic differentiant) of a co-variant is the same as the number of bonds in the chemicograph of the analogous compound radical. Every invariant and covariant thus becomes expressible by a *graph* precisely identical with a Kekuléan diagram or chemicograph. But not every chemicograph is an algebraical one. I show that by an application of the algebraical law of reciprocity every algebraical graph of a given invariant will represent the constitution in terms of the roots of a quantic of a type reciprocal to that of the given invariant of an invariant belonging to that reciprocal type. I give a rule for the geometrical multiplication of graphs, *i.e.* for constructing a *graph* to the product of in- or co-variants whose separate graphs are given. I have also ventured upon a hypothesis which, whilst in nowise interfering with existing chemicographical constructions, accounts for the seeming anomaly of the isolated existence as "monad molecules" of mercury, zinc, and arsenic—and gives a rational explanation of the "mutual saturation of bonds."

I have thus been led to see more clearly than ever I did before the existence of a common ground to the new mechanism, the new chemistry, and the new algebra. Underlying all these is the theory of pure colligation, which applies undistinguishably to the three great theories, all initiated within the last third of a century or thereabouts by Eisenstein, Kekulé, and Peaucellier.

Baltimore, January 1 J. J. SYLVESTER

PALMEN ON THE MORPHOLOGY OF THE TRACHEAL SYSTEM

DR. PALMEN, of Helsingfors, has recently published an interesting memoir on the tracheal system of insects. He observes that although the gills of certain aquatic larvæ are attached to the skin very near to the points at which the spiracles open in the mature insects, and though spiracles and gills do not co-exist in the same segment, yet the point of attachment of the gills never exactly coincides with the position of the future spiracle. Moreover, he shows that even during the larval condition, although the spiracles are not open, the structure of the stigmatic duct is present, and indeed that it opens temporarily at each moult, to permit the inner tracheal membrane to be cast, after which it closes again. In fact, then, he urges, the gills and spiracles do not correspond exactly, either in number or in position, and there can therefore be between them no genetic connection. He concludes that the insects with open tracheæ are not derived from ancestors provided with gills,

but, on the contrary, that the possession of a closed tracheal system is a secondary condition, derived from ancestors provided with spiracles.

He adopts the view that the existing insects are derived from an ancestor, in which the larvæ resembled the existing genus Campodea, with a hemimetabalous metamorphosis, and an open tracheal system ; and he dwells on the important fact that in Campodea each spiracle has an independent set of tracheæ. So also in the course of embryonal development, the tracheal systems rise separately, and then the anterior and posterior branches unite to form the lateral ducts.

In a still earlier stage he thinks it probable that the tracheæ resembled those of the curious genus Peripatus. He observes that the skin-glands of certain worms secrete not only fluid, but also gas (carbonic acid), and from this to an absorbing function would be a comparatively small step. He supposes, then, that the tracheæ are derived from the skin-glands of worms, passing firstly through the stage now represented by Peripatus, in which there are a number of tracheal tubes with numerous scattered openings ; secondly, though one represented now by Campodea and certain myriapods, in which the spiracles are situated in pairs, and are connected with separate tracheal systems. I. L.

ON THE EVOLUTION OF HEAT DURING MUSCULAR ACTION[1]

PROF. A. FICK, of Würzburg, in continuing his researches on the source of muscular power, has obtained some new and exceedingly important results, of which the following is a condensed account :—

It is obviously an interesting question in the physiology of muscle what fraction of the work yielded by chemical action in muscular tissue can be employed in overcoming mechanical resistance? the remainder of the chemical work appearing, in all probability, as heat.

Many years ago Helmholtz calculated, from certain considerations, into which, however, there entered several hypothetical factors, that possibly one-fifth of the total work yielded by chemical force in the human body might be employed in muscular action, the remaining four-fifths appearing as sensible heat. From this it necessarily follows that a much larger proportion than one-fifth of the work yielded by chemical force *in the muscle itself* can be employed in overcoming mechanical resistance, inasmuch as it is assumed that a great part of the oxidation takes place in other tissues, where mechanical work is quite out of the question, and where heat alone can be the result.

If, however, thermodynamical experiments show that of the chemical work going on in the muscle only a small fraction, not much exceeding one-fifth, produces mechanical effect ; then, supposing the coefficient of Helmholtz to be true, it would be proved that only minute quantities of combustible material are oxidised elsewhere than in the muscles. The author's experiments have been made with a view to answer the first of the above questions—what fraction of the chemical force eliminated in the muscle is used in mechanical work? Such experiments can, of course, with the present means of research, only be carried out upon the muscles of the frog. How far the results obtained are applicable to other classes of animals, is a distinct question.

Thus two magnitudes have to be determined in absolute measure, viz., the mechanical work performed by the muscle, and secondly, the amount of chemical work that the muscle has yielded during the action.

The amount of heat produced in the muscle was of course measured by multiplying the rise in temperature of the muscle by its capacity for heat. In the calculations the specific heat of muscle was taken as equal to that of water. It cannot be greater, and is probably not much less, inasmuch as three-fourths of living muscle are water. The rise in temperature was measured by thermo-electrical means. The galvanometer used had no fixed magnet, and its constancy was proved to extend over many weeks, and even months. The thermopile had to be so arranged that it was as much as possible surrounded by the mass of muscle ; its construction will be better understood after the preparation has been described. The gastrocnemius muscle, which is the favourite preparation in such experiments, was replaced by the masses of muscle which pass from the pelvis to the tibia on the inner side of each thigh, whilst the other muscles, with the sartorius and biceps, as well as both the thigh-bones, were removed. Then, on suspending the pelvis, the two prepared masses of muscle hung vertically downwards in intimate contact with each other, all the nerves belonging thereto being easily preserved. One end of the thermopile, with very flat and thin elements, was then placed in the fissure between the two masses of muscle, this arrangement being found by experience to be a perfectly trustworthy one.

A remark is necessary concerning the method of irritating the preparation. Some years ago the author had the opportunity of observing, in some unpublished experiments, that an electric current of sufficient strength to produce the most powerful contraction in a muscle, does not appreciably raise the temperature of the latter. Even with Heidenhain's exceedingly delicate thermopile there was scarcely any evidence of heat being produced in a dead muscle through which a current of twenty-four Daniell's elements was passing for several seconds ; and even induction currents of immense strength produced no visible thermal effect. This fact is of great interest in myothermic experiments, as it is thus no longer necessary to impart the stimulus through the nerve, but simply to subject the muscle to direct electrical irritation.

In his experiments, the author has adopted preferentially the method of direct irritation, one of the two copper wires connected with the induction-coil being attached to the pelvis, and the other to the knee of the frog.

The mechanical work was measured by connecting the preparation with one arm of a lever to which a weight was attached, and, in some of the experiments, there were also two balanced weights placed upon the lever to increase its inertia, by which it was found that the work performed was very considerably increased.

The following is a summary of the chief results arrived at by these experiments :—

1. By the interposition of a thin thermopile between suitable masses of muscle, it is possible to determine with great accuracy the absolute amount of heat produced by their contraction.

2. The determination of the muscle-temperature is not interfered with by electrical currents, which, for the purpose of irritation, are passed through the muscle. Therefore direct electrical irritation of the muscle is permissible, and indeed far preferable, in myothermic researches.

3. To the fundamental law of Heidenhain, that a muscle contracting to its greatest extent evolves more heat the greater its initial tension, we may now add that, with equal initial tension, a muscle will evolve more heat if, by means of weights in equilibrium, greater tension be produced during the contraction.

4. A muscle overcoming a greater resistance, works not only with more activity but also with more economy than when occupied in a smaller effort.

5. In an energetic muscular contraction against as great a resistance as possible the eliminated chemical force is about four times as great as the mechanical work it performs. With a less resistance the chemical is a greater multiple of the mechanical force, and with no resistance at all it is obviously indefinitely greater.

6. The amount of heat produced by the eliminated chemical force in an energetic contraction of 1 grm. of

[1] Ueber die Wärmeentwickelung bei der Muskelzuckung," in the *Archiv. f. Physiologie*, Band xvi.

untired frog's muscle is sufficient to raise 3 mgrm. of water from 0° to 1° C.

7. By adopting some very probable assumptions it can be inferred that the combustion of assimilated food, as far as the oxygen inspired is employed in producing chemical force, takes place almost exclusively in the muscular tissues. P. FRANKLAND

ERNST HEINRICH WEBER

WE are called upon to chronicle the death, at Leipzig, on January 26, of Prof. Ernst Heinrich Weber, whose name is so closely united with the fundamental principles of modern optics and acoustics. He was born at Wittenberg, June 24, 1795, and after having studied at the university of that city received, in 1815, the degree of M.D. Two years later he published a short work on the anatomy of the sympathetic nerves, which brought his name at once into prominence. The following year he was appointed extraordinary professor of anatomy at the University of Leipzig, and in 1821 he became ordinary professor of human anatomy. He was early well known by his edition of Hildebrandt's Anatomie, of which he wrote anew a considerable part, 1830. The chair of physiology was offered to him in 1840, and he actively fulfilled the duties of this position until a short time before his death. During this period he issued several manuals of physiology, and published a number of investigations, the most valuable of which are gathered together in his book "Annotationes anatomicæ et physiologicæ" (1851). Science is, however, chiefly indebted to Prof. Weber for the classical researches carried out by him and his brother Wilhelm Eduard while still young men, on which is grounded the celebrated wave-theory. The work in which their investigations are recorded—"Die Wellenlehre auf Experimente gegründet" (1825), is a remarkable relation of the most delicate and ingenious observations ever undertaken to establish a series of physical laws. Among the most notable of these might be mentioned the experiments on waves of water in mirrored troughs, by means of which they found that the particles near the surface move in circular paths, while those deeper in the liquid describe ellipses, the horizontal axes of which are longer than the vertical. By another series of comparative observations on water and mercury the law was established that waves moved with equal rapidity on the surfaces of different mediums, while the rapidity increases in both cases with the depth of the liquid. These and a multitude of other facts, studied and elaborated in the most scrupulous and conscientious manner, form the basis for the whole theoretical structure accepted at present as explanatory of the phenomena of light and sound. So thoroughly and scientifically were these researches carried out that subsequent physicists have never been called upon to correct them. In 1850 Prof. Weber completed an extensive series of experiments designed to study the wave-movement in the arterial system and explain the fact that the pulse-beat was felt at the chin a fraction of a second sooner than in the foot. The results showed that the pulse-beat travels with a rapidity of about thirty-five feet per second, and that in general the rapidity of a wave in small elastic tubes is not affected by the increase of pressure on the walls. At a later date Prof. Weber published some interesting results of experiments on the mechanism of the ear, as well as on the microscopic phenomena visible on bringing together alcohol and resin suspended in water in capillary spaces.

DR. P. BLEEKER

ON January 24 death quite suddenly overtook one of the most indefatigable workers in the field of zoological science, the well-known ichthyologist, Dr. P. Bleeker, who died at his residence in the Hague, at the age of fifty-nine. Born at Zaandam in 1819, he had an early taste for natural history, and studied medicine with a view to an appointment in the army. In 1838 he received an appointment in the medical staff of the East Indian army, and left for Batavia. Here an immense field was soon opened to his activity. He set himself to form an immense collection of fishes from different parts of the colonies, assisted in many ways by a number of his medical colleagues at different stations. He himself always remained at Batavia, gradually rising in his profession till he obtained the inspectorate of the Colonial Medical Service. At the same time he was the centre of a keen scientific movement in the capital of the Dutch Indies, starting several societies and taking the chair in the principal of them for many consecutive years. His contributions to the Indian ichthyological fauna were regularly published in Batavian scientific journals. In 1860 he returned to his native country, and first took up his residence at Leyden, with a view to comparing the treasures contained in the zoological collections there with his own. Extensive consignments of fishes had been made by him to this institution at the time of his residence in Batavia, part of the arrangement and determination of which he now took upon himself. Not long afterwards he went to live at the Hague, where the dignity of Councillor of State Extraordinary was conferred upon him. He set to work at the gigantic task he had undertaken—the publication of his "Atlas Ichthyologique des Indes Orientales Néerlandaises," seven volumes of which, illustrated by several hundreds of coloured plates have appeared. He was herein largely assisted by grants from the Colonial Government. Many important groups, the Gobioidæ, the Scombridæ, the Scorpænidæ, &c., as well as the whole of the Elasmobranchs are left unfinished. He himself estimated that little less than half of the work remained to be published, and latterly had misgivings whether he would really be able to finish it.

The number of separate publications on East Indian fishes which have appeared from his hand in different journals exceed three hundred; they form the basis on which he gradually raised the structure of his Atlas.

He had brought home his large collection of spirit specimens which has always remained in his private possession. Of late years, as he advanced with the publication of his Atlas, he disposed of the specimens of those groups which he had finished; in this way no less than 150 of his unique type-specimens were acquired by purchase by the British Museum. Another disadvantage under which a private collection of these dimensions often labours—and Bleeker's was no exception—is the loss of the exact localities from which the different specimens of one species were procured, a detail which is afterwards of such high importance in determining the geographical range of varieties. Here, however all the specimens are mixed together in one bottle without being separately labelled.

An extensive collection of reptiles and amphibians from the Archipelago, on which he had published several papers during his stay in India, have passed to the British and Hamburg Museums.

ABOUT FISHES' TAILS

MOST people know the difference in shape that there is between the tail (caudal fin) of a salmon and that of a shark; how in the former the lobes of the fin seem to be equal or symmetrical (homocercal), and in the latter only the lower lobe of the fin is, as it were, developed, and the back bone (vertebræ) of the fish seems to be prolonged into the feebly-developed upper lobe (heterocercal). This remarkable distinction was first of all recognised by Agassiz, and long ago Owen wrote, "the preponderance of heterocercal fishes in the seas of the geological epochs of our planet is very remarkable; the prolongation of the superior lobe characterises every fossil fish of the strata anterior to and including the magnesian limestone; the

homocercal fishes first appear above that formation and gradually predominate until, as in the present period, the heterocercal bony fishes are almost limited to a single ganoid genus (Lepidosteus)." "Indeed," writes Prof. Owen in another place, "it [the heterocercal] was the

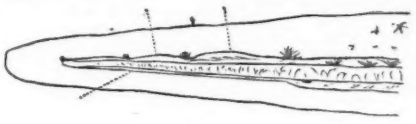

FIG. 1.

fashion of tail which prevailed in fishes throughout the palæozoic and triassic periods." It never seems to have been settled whether the fish with the homocercal tail was or was not better off than the fish with the heterocercal tail. If the more recent fishes have improved in this matter of tails upon the more ancient fishes, as was to have been

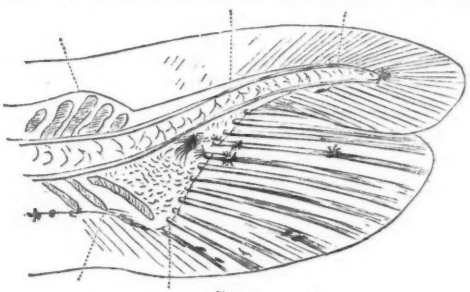

FIG. 2.

expected, certain it is that the shark of to-day can wheel quickly enough about in pursuit of his prey, and that the sword-fish can come thundering against a ship's timber with a vigour not easily matched by any fish with a symmetrical tail. Be this, however, as it may, the structure of fishes' tails has engaged the attention of most of our comparative anatomists, and the student will find large stores of facts collected and arranged for him by Agassiz, Vogt, Owen, Kölliker, Hæckel, Huxley, and Lotz. The latter four anatomists have plainly shown that while the external appearance of the tail of modern bony fishes is, as we have seen, homocercal, their real structure is only a modified heterocercal one, so that, as far as we now know, the tail of all fishes is built upon modifications of the same type, and in a paper just published by Alexander Agassiz, "On the Young Stages of some Osseous Fishes," he proves still further that this tail fin does not differ in its mode of development from the primitive embryonic fin, or from that of the back (dorsal) fin. He describes the gradual change of the

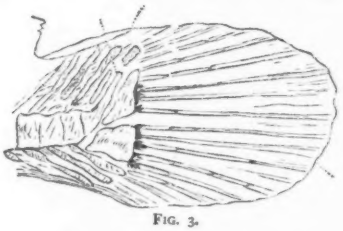

FIG. 3.

embryonic tail in several species of bony fishes, and he calls attention to the remarkable presence of an embryonic caudal lobe, which has, to this, apparently escaped the attention of naturalists, and which shows remarkably well the identity of growth between the tails of ganoid and of bony fish.

Alexander Agassiz traces the changes gradually taking place in the tail of the common flounder, from the time the little fish leaves the egg until it has nearly assumed the final shape of the adult. At first (Fig. 1) the caudal end of the chorda is straight. The caudal fin is rounded. In the next the caudal extremity of the chorda has become slightly bent upwards, and there will be found the first

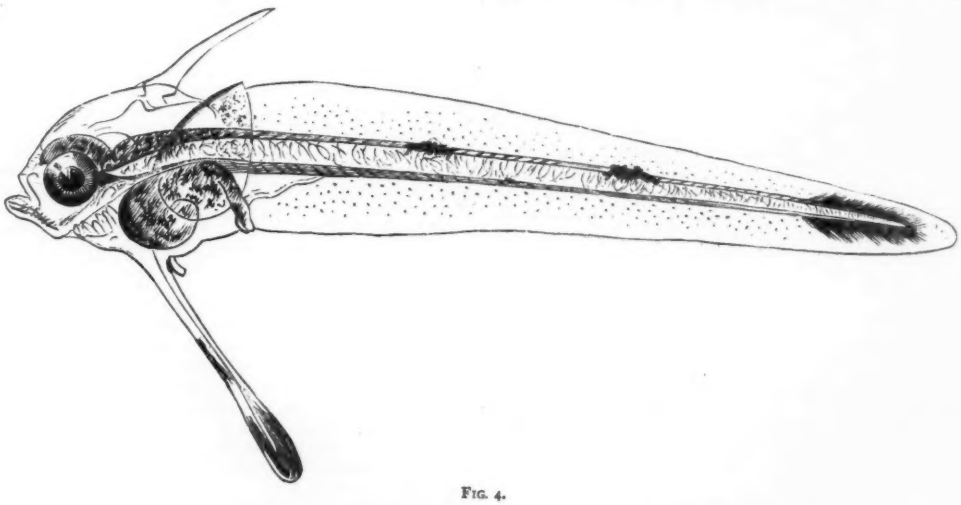

FIG. 4.

trace of the division line between the embryonic and the permanent caudal fins. In further stages this indentation between these two becomes more marked the chord becomes more arched, and the permanent caudal at length projects well beyond the outline of the embryonic fin fold, so that antecedent to the ossification of any of the vertebral column, the tail has assumed a heterocercal form.

In the stage (Fig. 2) in which the embryonic caudal assumes the shape of a large independent lobe, while the

permanent fin appears like a second anal fin, the resemblance to the tail of a young Lepidosteus is most striking. The extremity of the notochord at last disappears preparatory to the formation of the urostyle, while the permanent caudal gradually develops, and soon it (Fig. 3) presents the general outline of the adult form.

A. Agassiz has traced the presence of this remarkable embryonic caudal-lobe in a large number of genera of bony fish. In the young of Syngnathus it is well marked. In the young of the fishing-frog (Fig. 4) (*Lophius*) the termination of the notochord remains unchanged quite late in life, but in all the genera examined the permanent tail passes quite gradually from a strictly ventral appendage placed below the dorsal column to that of a terminal tail placed in the continuation of the vertebral column.

A. Agassiz thinks that though Agassiz and Vogt were mistaken as to their details, their great generalisation will still remain true, and that there is a complete accordance between the embryonic growth of fishes' tails and the development of fishes in time, only we must now remember that the heterocercal tail is *not* the earliest stage—that the earliest stage is a nearly symmetrical one; this which he calls the leptocardial stage is that assumed by the tails of bony as well as of all other fishes, and *precedes* the heterocercal stage. As to the palæontological record, if one examines the tails of the Devonian fish as we know them from the restorations of Agassiz, Hugh Miller, Hæckel, Huxley, and others, one is quite struck by the perfect parallelism of these ancient fishes, as far as the structure of their tail is concerned, with the structure of the stages of the flounder's tail already referred to, thus carrying out the parallelism of Agassiz and Vogt far beyond anything they even conjectured. This important paper of A. Agassiz was presented to the American Academy of Arts and Sciences in October last, and for an early copy of it we are indebted to the author.

E. PERCEVAL WRIGHT

OUR ASTRONOMICAL COLUMN

LITERATURE OF THE NEBULÆ AND CLUSTERS.—No. 311 of the *Smithsonian Miscellaneous Collections* is just received. It contains an "Index Catalogue of Books and Memoirs relating to the Nebulæ and Clusters, &c.," by Prof. Holden, of Washington, commenced in 1874 for his own use, and now published in the hope, as he states, that it may be found as useful to others as it has already been to himself. It is believed to be nearly complete so far as the uses of the astronomer can require, but it has not been Prof. Holden's object to make an index for the bibliographer. The present catalogue affords facilities in the several cases that are most likely to arise, as first, in the event of all that is published on nebulæ and clusters in a particular series—the *Philosophical Transactions*, for instance—being required; again, where all papers upon the subject by any one author are sought for, and further, when all papers written upon any special subject, no matter by what author, are in question. A very useful indication of the contents of a large number of the memoirs and notices forms a feature in the work, Sir W. Herschel's papers being noticed in abstract with particular fulness. The great nebula in Orion and the variable nebulæ claim separate sections. There are also lists of figured nebulæ and an index to Sir W. Herschel's Catalogues adopting the identifications of his son's General Catalogue.

Prof. Holden has rendered an essential service to all who may be occupied with this interesting branch of astronomy, who will find his index of the greatest assistance in enabling them to learn, at the expense comparatively of little time and trouble, all that has been written upon many special subjects and upon the nebulæ and clusters generally.

NEW SOUTHERN VARIABLE STAR.—Mr. Tebbutt—who, it will be remembered, was the discoverer of the great comet of 1861 while yet telescopic—writing from Windsor, New South Wales, on November 23, notifies his having detected what would appear to be a remarkable variable star in the constellation Ara. He had seen it as a star of the fifth magnitude while observing Comet III., 1862, between October 3 and 9; it was then brighter than σ Aræ, and plainly visible to the naked eye. Its place was fixed by sextant-distances from four stars. At the time of writing, Mr. Tebbutt mentions that the only star in the observed position was one of the eleventh magnitude, barely distinguishable in moonlight in his 4½-inch equatorial. When this star was placed in the centre of a field of about 45′, no stars above the tenth magnitude were visible. But, in this case, what has become of No. 6142 of the Paramatta Catalogue, rated 7·8 m.? Mr. Tebbutt found the place of his star for 1878·0, R.A. 17h. 30m. 13s·2, N.P.D. 135° 24′ 17″, in which case Brisbane's star would be distant 16″·8 on an angle of 193°, and should therefore have been in the field.

While writing on the subject of variable stars, we may mention that the *Annuaire du Bureau des Longitudes* for 1878 contains very full lists and ephemerides of these objects, which have been ably prepared from Prof. Schönfeld's catalogue and other sources by M. Lœwy, who now has charge of the popular French work. In other respects the *Annuaire* for the present year is to be recommended as a valuable repertory of scientific facts and data.

THE ROYAL OBSERVATORY, BRUSSELS.—M. Houzeau, the successor of the late M. Quetelet in the direction of this establishment, has issued his report on the work of the year 1877. The Observatory is at present in a transition state, the instruments which have long been in use being about to be replaced by others of greater capacity. A meridian circle, almost entirely similar to that constructed for the new Observatory at Strasburg, has been ordered from Repsold; and Dent, of London, supplies the standard sidereal clock, to be accompanied by a chronograph: various modifications have been introduced into these instruments after careful consideration. A refractor of 38 centimetres aperture is in course of construction by Merz, the object-glass having already arrived at Brussels. The ancient meridian instruments have been employed on the observation of stars exhibiting decided proper motion, a work long pursued. On the mounting of the large refractor, M. Houzeau proposes to fix his attention upon three principal objects:—1st. Micrometrical measures of a certain number of double stars—binaries, and those which are affected with rapid proper motion. 2nd. To observe, with particular care, the passages of the satellites of Jupiter across his disc, and their occultations and the transits of their shadows. 3rd. Spectroscopic observations, for which a smaller refractor will also be available. Meteorological observations which have occupied much of the time of the observers during M. Quetelet's superintendence, will be continued, but in a department distinct from that devoted to astronomy, a very necessary arrangement if observations of a routine nature are not to be allowed to interfere with those of a higher class.

A FORECAST OF THE SATELLITES OF MARS.—In the last number of the *Astronomische Nachrichten*, Prof. von Oppolzer, of Vienna, draws attention to the curious passage in the "Travels into Several Remote Nations of the World by Lemuel Gulliver"—of Swift, which he transcribes from the edition of 1755. A correspondent of the *Times* referred to the same passage soon after the discovery of the satellites of Mars by Prof. Asaph Hall became known in this country. We read "they have likewise discovered two lesser stars or satellites which revolve about Mars, whereof the innermost is distant from the centre of the primary planet exactly three of his diameters, and the outermost five; the former revolves in the space of ten

hours, and the latter in twenty-one and a half; so that the squares of their periodical times are very near in the same proportion with the cubes of their distances from the centre of Mars, which evidently shows them to be governed by the same law of gravitation that influences the other heavenly bodies." This idea of Swift's, which appears to have only recently come to the knowledge of Prof. v. Oppolzer, is so singular a one taken in connection with the facts of the discovery of the satellites of Mars, that it is not surprising the editor of the *Astronomische Nachrichten* should have transferred it to his columns. Possibly the opinion which has prevailed largely amongst astronomers that, if satellites of Mars existed, they must be very small and close to his disc, may have had originally some connection with Swift's fancy.

BIOLOGICAL NOTES

PAPUAN PLANTS.—In the Appendix to Baron von Mueller's "Descriptive Notes on Papuan Plants," which we have just received we find some interesting additions to orders already considered, and which we have had occasion to refer to before. In Leguminosæ, *Acacia holosericea* is recorded from Geelvink Bay, found by Beccari; from the Fly River, by D'Albertis; and Baxter's River, by Reedy. In Myrtaceæ are four additions—*Tristania macrosperma*, *Myrtella beccarii*, *M. hirsutula*, and *Bæckea frutescens*. A remarkable myrtaceous plant, with the habit of a *Psidium*, is stated to be contained in Dr. Beccari's collection, which Baron Mueller thinks is probably referable to the genus *Eugenia*. The only flower available for examination had eight petals, being double the number of the calyx lobes. Unless this augmentation arose from monstrous growth we are reminded that we have here a species abnormal not only in the genus *Eugenia* (and to which the name of *E. pleiopetala* might be given), but also in the whole order of Myrtaceæ, except *Gustavia*. From Mount Arfak, at an elevation of about 6,000 feet Dr. Beccari obtained the first epacrideous plant recorded from New Guinea, though in all likelihood others will yet be detected in the higher mountain regions.

HORSE-SHOE CRABS.—With reference to the fact that large numbers of trilobites are found on their back, and the inference that when living they probably swam in this position, Mr. Alex. Agassiz states (*Sillimann's Journal*) that he has for several summers kept young Limuli (horse-shoe crabs) in his jars, and has noticed that besides often swimming on their backs, they will remain in a similar position for hours, perfectly quiet, at the bottom. When they cast their skin it invariably keeps the same attitude on the bottom of the jar. It is not uncommon to find on the shores, where Limuli abounds, hundreds of skins thrown up and left dry by the tide, most of which are turned on their backs. Again, young Limuli generally turn on their back while feeding. Moving at an angle with the bottom, the hind extremity raised, they throw out their feet beyond the anterior edge of the carapace, browsing, as it were, on what they find in their road, and whisking away what they do not need by means of a powerful current produced by their abdominal appendages.

GREEN ALGÆ.—Our knowledge of the life-history of those green-coloured algæ which seem to possess a true reproductive system, is progressing with rapid strides, and in the *Botanische Zeitung* for October and November last two most remarkable papers on two well known (so far as external form goes) species have very considerably advanced our knowledge of the group. The earlier in date (October) of these two memoirs is by the well-known botanists Rostafinski and Woronin on *Botrydium granulatum*. This alga was described by Ray nearly 200 years ago, and is probably known to many as growing up in damp clayey spots, and presenting the appearance of bright green blobs about the size of large mustard seeds. Common as this plant is, it is only now that after several years' consecutive watching the authors have been able to clear up the mystery of its life, and to determine that the formation of ordinary zoospores can eventuate in the four following ways (*a*) from the vegetative plant, (*b*) from an ordinary zoosporangium, (*c*) from the root-cells, and (*d*) from a Hypnosporangium: and as still further means of increase we have (*e*) cell division, (*f*) formation of spores, and (*g*) formation of isospores. Botrydium would also seem to enjoy a five-fold resting state: 1. The asexual aquatic zoospores with a quiescence of one month. 2. The root-cells, quiescence the year through in which they are formed. 3. The hypnosporangia, quiescence the same. 4. The spores, quiescence a year. 5. The isospores, quiescence at least over the year in which they were formed. The next memoir is a joint one by A. de Bary, the able editor of the journal, and E. Strasburger, and is about that very beautiful green seaweed not uncommon in the Mediterranean, called *Acetabularia mediterranea*. This genus was so called by Lamouroux on account of the saucer (acetabulum) like form assumed by the little rows of filaments that crown the cylindrical stalks. There are three species known, perhaps they may be all varieties of the one now referred to. Prof. de Bary was only enabled to watch the progress of the spore development to a certain stage, but by Strasburger's researches, carried on at Spezia, we are enabled to read the whole history and to know that the motile bodies of protoplasm set free from a mother-cell, can and do conjugate, forming a resting body which can and does vegetate. At the close of this memoir Strasburger proposes that we should call the body formed by the conjugation of the contents of two cells (Gametæ) by the name of Zygote, and that those plants whose Gametæ are active might be called Planogameta, and those where (as in Desmids) the Gameta are at least quasipassive, might be called *Aplanogameta*.

DEEP SEA ASCIDIANS.—Mr. H. N. Moseley has published (*Transactions*, Linnean Soc. S.S. Zool., vol. 1) a description, accompanied by excellent figures, of two very remarkable forms of ascidians. The first described was obtained from the great depth of 2,900 fathoms in the North Pacific Ocean, and is called *Hypobythius calycodes* in allusion to its occurrence at so vast a depth and to its cup-like form. Its outer skin is hyaline and extremely transparent, but in certain places it is strengthened by the presence of tough cartilaginous plates, and these are arranged in a nearly symmetrical manner. It is attached by means of a stalk. It is probably allied to the genus Boltenia, but is abundantly distinct from all known forms. The second is a beautiful stellate form taken 1070 fathoms, not far from one of the Schouten Islands. From its having eight long radiating processes it was at first taken for a medusoid form. Its test is hyaline and gelatinous and it is also an attached form, but the stalk is short. The respiratory sac is flattened out so as to become nearly horizontal, and there is no gill net-work present. It has been called *Octacnemus bythius*.

THE BYSSUS IN THE MUSSEL.—Tycho Tulberg has published in the *Transactions* of the Royal Society of Natural History of Upsala (July, 1877) an account of the structure of the byssus-forming gland in *Mytilus edulis*. The strong silky threads formed by this gland, which moor the mussel shell so firmly to its resting-place, must be familiar to most. In an allied genus (Pinna) these threads have been even spun and formed into gloves. The manner in which the tongue-like foot can affix these threads is easily to be seen by watching a small specimen of the common mussel when in a healthy condition and confined in a glass jar. The minute structure of the gland that secretes the threads is well described by Mr. Tulberg, who promises further to publish an account of

the structure of this organ in some other species of byssus-forming bivalves.

AQUATIC RESPIRATION.—Some experiments on the breathing of aquatic animals (both fresh and salt water) have been recently described by MM. Jolyet and Regnard in the *Archives de Physiologie*. The results are briefly as follows:—These animals, living in a medium very poor in oxygen, and having a blood-liquid with small respiratory capacity, have the least vigorous respiration. In the free natural act of respiration the oxygen which disappears is not exactly represented by the oxygen in the carbonic acid produced; the ratio $\frac{CO_2}{O}$ is always less than 1; *i.e.*, aquatic animals, in the normal state, never give off more carbonic acid than the oxygen they absorb. (The opposite result got by some physiologists is attributed to keeping the animals in an enclosed medium whose oxygen they gradually exhausted.) As with other animals, heat-variations in the surrounding medium has a marked influence on the chemical phenomena of respiration. Taking 2° and 30° as the limits of bearable external temperature, the quantities of the absorbed oxygen vary (other conditions being equal) in the ratio of 1 to 10. Among other causes which may have an influence on the vigour of breathing (apart from those connected with species) the most important, after temperature, are the state of hunger and digestion, the amount, and the greater or less intensity of muscular action. In the experiments there was sometimes a slight development of nitrogen, sometimes an absorption. No definite opinion could be expressed with reference to this point.

GEOGRAPHICAL NOTES

EXPLORING COLONIES.—The Société des Colons Explorateurs, lately organised in Paris, is developing a most healthful degree of activity. Its purpose is to organise a systematic method of exploration and colonisation, based on the same principles as those which animate the newly-founded international society for the exploration and civilisation of Africa, but embracing in its field all the undeveloped portions of the globe. The Society has formed two councils to direct its operations. In the first, which is charged with the scientific, geographical, and exploratory sections, we notice the names of Malte-Brun, de Lesseps, de Quatrefages, Milne-Edwards, Admiral La Roncière le Noury, &c. The second, devoted more especially to agriculture, commerce, and industry, embraces Michael Chevalier, Tisserand, Col. Solignac, F. Garnier, and other well-known names. The plan adopted by the Society for the attainment of its objects is eminently practical. A colony is formed from representatives of various classes and occupations, who are well fitted to investigate and develop the resources of a new country; it is provided with a complete equipment, and despatched to a promising locality. Here a firm foothold is established, and the new settlement made, as soon as possible, not only self-supporting, but a centre for geographical and general scientific investigation. The band of permanent colonists are accompanied by a certain number, who, after obtaining a degree of familiarity with the difficulties to be overcome in a new settlement, are ready to form the nucleus of a new colony. In this manner not only will the various colonies increase the sphere of their activities at a rapid rate, but drill at the same time groups of hardy explorers well fitted to extend the circle of the Society's undertakings. The first experimental colony has already been started on the coast of Sumatra, and embraces in its *personnel* graduates of the leading technical and professional schools of Paris. If this simple practical programme is carried out successfully, it is evident that the new Society, increasing the extent of its operations in arithmetical progression, will soon become a most important factor in the slow process of civilising the world.

SUMATRA.—In the January session of the Dutch Geographical Society it was announced that Lieut. Cornelissen had been appointed to take charge of the Sumatra exploring expedition, lately deprived by death of its commander, M. Schow-Sandvoort. He leaves in March to assume the direction of the explorations. During the past three months 14,000 guilders have been contributed for the Sumatra exploring fund.

NIAS ISLAND.—In Petermann's *Mittheilungen* for February is a very full account, with map, of the Island of Nias, on the west of Sumatra, by Dr. A. Schreiber. The island now belongs to the Dutch, and by them has in recent years been pretty thoroughly explored. The island is hilly, the highest summit being 2,000 feet, the formation being mostly sandstone and coral.

ARCTIC EXPLORATION.—Admiral La Roncière le Noury in his capacity of president of the Paris Geographical Society, M. Quatrefages, and M. Maunoir, general secretary, have written an official letter to Capt. Howgate, U.S.A., conveying to him their approbation of his scheme for establishing a polar colony in Lady Franklin Bay. They trust this document may induce the Congress to vote the required credit for starting the contemplated expedition. They express, moreover, their gratitude for the sending out of Capt. Tyson's preliminary expedition, and they trust Capt. Howgate will soon be in a position to take advantage of the means which his hardy lieutenant has been sent to collect. Capt. Howgate has written to the Danish Government, asking them to send instructions to the Disco authorities, authorising them to place the Government storehouse at the disposal of Capt. Tyson, if he has failed in collecting a sufficient number of furs during the present winter season. Mr. S. R. Van Campen has been asked by the Hon. B. A. Willis, of the Committee on Naval Affairs in the United States Congress for a report on the Arctic expeditions abroad, and has complied with the request. Besides speaking particularly of the proposed expeditions of Holland and Sweden, Mr. Van Campen suggests to the Committee, as it has in charge the bill now before Congress for an American expedition, proposed in accordance with Capt. Howgate's scheme, the incorporation of a clause granting rewards upon a graduated scale to individual explorers of whatever nationality, who may reach latitudes or make discoveries in Arctic territory beyond points hitherto attained.

ROHLFS' EXPEDITION.—Herr Gerhard Rohlfs has received no less than 300 applications for participation in his expedition to the Libyan Desert. Of course the great traveller can only consider very few of them. We learn further that he intends also to explore the Shari, Binue, and Ogowai Rivers and their tributaries. We hope he will succeed in accomplishing this, as it will solve many of the questions raised by Stanley's discovery of the course of the Congo. The date of his departure is not yet fixed.

SPITZBERGEN.—A very interesting series of nine maps of Spitzbergen, partly rare and little known, are published in the *Tijdschrift* of the Amsterdam Geographical Society, with an essay by Capt. de Bas, on the geographical names of Spitzbergen. The maps begin with that of Barentz's third voyage of 1596, followed by those of Gerritz, 1612; Edge, 1625; Middlehoven, 1634; Daniel, 1642; two others of 1648, and the latter half of the seventeenth century; that of Johannes van Keulen, 1710, and finally the Dunér-Nordenskjöld map of 1864.

JAPAN.—In the *Monatsbericht* of Petermann's *Mittheilungen* for February, Dr. Behm gives some information concerning recent geographical work in Japan. There is an itinerary by Dr. Schulz, of a journey he made in

August, 1877, from Tokio to Hatsuishi (Nikko), and from Nikko to Takasaki; an account of the observations made by Dr. Naumann last summer during a journey into the little known western part of Nippon, and another at the same time into the north of that island by Herr Gebauer; and some information from the *Tokio Times*, by Y. Watanabe, on Chikuzen, a province in the north-west of the Kiushiu.

NOTES

THE following grants have just been made from the Research Fund of the Chemical Society to aid the carrying out of the following researches:—50*l.* to Dr. Wright, of St. Mary's Hospital Medical School for the continuation of his researches in chemical dynamics; 25*l.* to Dr. Armstrong for an investigation of camphor and allied compounds; 20*l.* to Dr. Carnelly, of Owens College, Manchester, for a research on the hydrocarbons diphenyl, ditolyl, &c., and their derivatives; 10*l.* to Mr. P. Phillips Bedson, of Owens College, Manchester, for a research on derivatives of phenyl acetic acid, and on the constitution of isatin; and 5*l.* to Mr. J. R. Crow, of Owens College Manchester, for a research on the action of zinc ethyl on the chloride of vanadium.

WE regret to announce the death, at Nice, of the celebrated Danish conchologist, Dr. A. L. Mörch.

WE hear with great regret, from an Italian correspondent, that the well-known astronomer, Father Secchi, has been seriously ill for several weeks, and that little hope is entertained of his recovery. The Roman correspondent of the *Lancet* states, however, that Dr. Ceccarelli, who is attending him, does not absolutely despair of his recovery. Father Secchi is not yet sixty, and is of robust frame.

AT the General Monthly Meeting of the Royal Institution on Monday, Dr. Warren De la Rue, D.C.L., F.R.S., in the chair, the special thanks of the members were given to Mr. William Bowman, F.R.S., for his present of an ivory bust of Prof. Faraday, by the late Matthew Noble, M.R.I. In reference to the telephone which Mr. Preece had explained to the members last Friday, the chairman stated that he had made attempts to measure the current produced by the vibrations of the disc of iron in front of the magnet of the telephone, and that he was unable to detect any by means of a most sensitive dynamometer which would render evident the current of a Daniell's cell through 2,000 ohms. Moreover, by other experiments made by other means, he concluded that the current produced did not amount to that which a Daniell's cell would send working through 100,000,000 ohm resistance.

THE New York *Tribune* gives an account of a public exhibition in that city of Eddison's Phonograph, which seems to have been very successful. The tones reproduced by the vibrating disk of the machine were so distinct that they could be heard and understood in different portions of the crowded room. Words spoken in a high key and with forcible emphasis were reproduced with much greater distinctness than those spoken in a low tone, even when the latter were uttered very loudly. A difference in the sound of different voices could be easily discerned. Several fragments of songs were sung in a high key and repeated by the machine with wonderful fidelity. The inventor stated that the machine has yet to be perfected before its full power is developed, and that ultimately it can be used to receive and reproduce the songs of popular singers as they are rendered on the stage.

AT a recent meeting of the Royal Society of Edinburgh, in connection with a letter from New York describing the phonograph, Sir William Thomson gave some explanation of the machine. All previous attempts to record sound were, he said, founded on the motion of a style or marker at a true parallel to the paper. Mr. Eddison's ingenious invention of the electric pen was different. It consisted of a fine point, which, by an excessively rapid vibration perpendicular to the paper, caused by a small electric machine connected with two thin wires to the point, left a trace of any person's handwriting in a row of very fine holes, from which the handwriting could be printed. Mr. Eddison, from this invention, elaborated the phonograph. By the greater or less pressure produced through the action of the alternate condensation and expansion of the air caused by the mechanism of the voice, the diaphragm operated upon the point and recorded the sounds. It was the most interesting mechanical and scientific invention they had heard of in this century. There could be no limit to its application. A man could speak a letter through the phonograph—it would be recorded on tinfoil, sent in an envelope through the post, and his friend, by applying the point of the phonograph to the tinfoil, could reproduce the words and tones uttered. In fact they could take down the singing of a Titiens (had we one), which might be reproduced to a tone two hundred years hence.

BOTH Houses of Legislature have unanimously passed a resolution giving the thanks of the U.S. Congress to Mr. Henry M. Stanley for his achievements in the field of African exploration. Mr. Stanley meets the Geographical Society in St. James's Hall to-night. It would be interesting to know how many applicants beyond the 2,000, which the hall will hold, have been disappointed. The officials of the Society have had a trying time of it in attending to the loads of applications they have received. Mr. Stanley will be entertained at dinner by the Society on Saturday.

IN connection with the recent election of Prof. Simon Newcomb as a foreign member of the Royal Society, it was stated that previous to that Prof. Asa Gray was the only living American who enjoyed that honour. We find, however, among the list of foreign members the name also of Prof. Benj. F. Peirce, of Cambridge, Mass.

WE have received an interesting volume: "Estudios sobre la flora y fauna de Venezuela," by A. Ernst. The author, in two ably written articles, gives a general idea of each of the two large kingdoms as they appear in Venezuela, and further adds some details on the fungi, orchids, molluscs, and birds of that country. The book is published at Caracas, and consists of over 100 quarto pages.

THE first meeting of the Institute of Chemistry of Great Britain and Ireland was held on Friday afternoon at the rooms of the Chemical Society, Burlington House. Prof. Frankland, F.R.S., the first President, read an address in which he gave an account of the origin of the institute. At a dinner given to Prof. Canizzaro on the occasion of his visit to London in May, 1872, Prof. Frankland drew attention to the increasing importance of chemistry in relation to the wants of communities, and suggested the usefulness of an institute that should be to chemists what the Colleges of Physicians and Surgeons are to the medical profession, the Institute of Civil Engineers is for civil engineers, and the Inns of Court are to the legal profession. Although the need of experts in connection with water and gas analysis, legal proceedings, and nuisances was recognised, and the application of chemistry to agriculture and manufactures was known to be of great importance, the suggestion was not taken up in a practical way until the beginning of 1876, when a meeting to consider the subject was held at the rooms of the Chemical Society on April 26. A committee was appointed to draw up a scheme for the constitution of the institute, which was laid before a meeting held in November. At one time it was thought that the objects might be effected by

establishing a separate branch of the Chemical Society with the Fellows of the Chemical Society. After much discussion the formation of the present institute was decided on. The institute has power to appoint examiners as to the fitness of candidates for its membership. Prof. Frankland, in the course of his address, drew attention to the fact that under the Pharmacy Act of 1868 no one, not even the President of the Chemical Society, may call himself a chemist unless he is duly registered as a pharmaceutical chemist. There are already 225 members and 142 associates, and a fund of over 1,000*l.* for the new institute.

THE Naturwissenschaftliche Gesellschaft of Jena celebrated the twenty-fifth anniversary of its foundation on January 17 last. Upon that occasion Mr. Charles Darwin, Prof. M. I. Schleiden, of Wiesbaden, and Prof. Oscar Schmidt, of Strasburg, were named honorary members of the society.

FURTHER information shows that the earthquake of Monday, January 28, was felt at several places in London, at Ryde, Osborne, Southampton, and Lyme Regis. Shocks were felt in Neumarkt at 10 A.M. on the 27th and 5 A.M. on the 28th. At Judenburg (Upper Styria) two different shocks were felt on the 27 h, at 10.6 A.M., and on the following day at 4.32 A.M. At Waldshut, on the Rhine, in the Grand Duchy of Baden, an earthquake was felt on the evening of January 16 shortly before midnight. The shock lasted about a second and seemed to proceed in the direction from south-west to north-east. Subterranean noise was plainly audible. The same phenomenon was simultaneously observed at Alb, Karsau, Beuggen, Schopfheim, and other places in Baden, as well as in all the north-westerly cantons of Switzerland.

THE recent investigations of Sergius Kern, resulting in the discovery of davyum to which we have had occasion frequently to refer, are being submitted to a careful examination in the Heidelberg laboratory under the direction of Prof. Bunsen. The results so far coincide with those of the Russian chemist, and it is to be hoped that the entire research may stand the crucial test of the leading authority on the platinum metals.

M. PICTET delivered, during the past week, two very interesting addresses in the laboratory of the École de Médecine, before the chemists of Paris, in which he gave a very complete and detailed description of his late experiments on the liquefaction of gases. He is a young man of scarcely thirty, an easy and fluent speaker, and made a pleasant impression on his Parisian auditory. A *brochure* of 100 pages, which he has just issued, with drawings, gives a very elaborate description of the whole series of experiments on the compression of gases.

THE Hon. Rollo Russell sends us some notes on experiments he has made which go to prove that there is no need to insulate the wires connecting a pair of telephones, at least when used for short distances. No. 18 uncovered copper wire was laid along grass and trees 418 yards, the two lines being kept well apart. Articulation and a small musical box were very well heard. The same wire buried for three yards in wet clay, the lines being about 5 ft. apart and the telephones 20 yards apart, gave good results, and it appears that the bare wires may be taken under roads, &c., without diminution of the audible effect. With the same wire taken across a pond, the lines being submerged in water about 40 yards, and lying on the grass the rest of the distance about 28 yards—the wires were about a yard apart in the water—conversation in low tones was distinctly heard when not overpowered by the noise of a strong wind blowing at the time. Probably No. 18 copper wire, uninsulated, might be laid across rivers and straits and used for telephonic purposes without appreciable loss of sound, as Mr. Russell, not in any of the above cases, noticed a feebler effect than with insulated wires.

INTERESTING antiquities have recently been excavated at Neumagen on the Moselle. The Roman poet Ausonius mentions in his "Mosella" that the Emperor Constantine possessed there a "beautiful castle," which was doubtless destroyed about the middle of the fifth century when Treves was several times ravaged by the Franks. About a century afterwards the famous castle of Nicetia was built by the Archbishop Nicetius, who probably utilised the foundations of the old Roman structure. Nicetia was rased to the ground in the year 881 by the Normans. Many of the old foundations are now being again excavated and are tolerably well preserved; the materials of which they are constructed are sandstone, marble, and limestone.

M. MARIÉ DAVY has published, through Gauthier Villars, the Montsouris Observatory's Meteorological *Annuaire*. The volume contains a number of important improvements.

THE first ordinary meeting of the newly-established Physical and Chemical Section of the Bristol Naturalists' Society was held on January 22 in the Library of the Bristol Museum. A paper was read by Mr. W. W. Stoddart, F.C.S., F.G.S., "On a Remarkable Occurrence of Indican in the Human Body." A paper was then read by Mr. S. P. Thompson, B.Sc., B.A., of University College, Bristol, "On Vortex Motion in Liquids." The paper was illustrated by experiments showing the production of smoke rings in air and of rings of coloured liquid in water. The author had lately tried the action of electromagnetism upon the rings projected through water and had observed their retardation and partial destruction in passing through a powerful magnetic field. His experiments are at present incomplete.

THE third volume of C. L. Michelet's "System der Philosophie als exacter Wissenschaft" (Berlin: Nicolai) will shortly be published. It will contain the philosophy of the mind. The fourth volume will treat of the philosophy of history and will close the interesting and elaborate work.

EXPERIMENTS with a new telegraph apparatus have lately been made at Vienna, by means of which some 100 or 120 messages may be sent by a single wire in the remarkably short space of one hour. Under certain conditions this number may even be raised to 200 or even 250 messages. The inventor of the new apparatus is Herr August Eduard Granfeld, an Austrian telegraph official. At the end of December he presented to the Austrian "Telegraphenanstalt" eight working and two principal apparatus of his invention for practical trials. The experiments were crowned with complete success.

A NEW watchman-controlling clock has been constructed by Messrs. Fein at their telegraph works at Stuttgart, which on a single dial records the times at which a watchman visits any given number of stations however far apart, as well as the succession in which they are visited, and thus also the intervals which elapse while the man is proceeding from place to place. The same firm has constructed an automatic alarum for uninhabited or locked localities.

IT is stated that such enormous quantities of snow are now lying in the Austrian "Salzkammergut" as have not been seen there for the last fifty or sixty years, and a sudden thaw is dreaded extremely, as it would unavoidably cause enormous inundations. News from Pesth reports that on January 27 the Danube broke through the dykes at Dömsöd, and caused a vast inundation in Kumania, for a distance of some fifty miles, as far as Baja. Nine villages are under water. Other inundations are reported from the valley of the Vesdre River in the eastern part of Belgium.

AN exceptionally mild winter is reported from the north-western states of North America. In the districts near St. Paul, Minnesota, the farmers ploughed their fields in Christmas

week. On Christmas Day excursions were made by steamer on the Mississippi River. In former years the river was generally frozen over on that day.

THE Vienna Society for the Protection of Animals offers a prize of thirty ducats in gold for the best pamphlet recommending the protection of animals. The little work must be of general interest and must be written specially for teachers. It must be in the German language and is not to exceed six sheets in print. Competitors must send in their manuscripts, on or before July 1 next, to the Committee of the Society at Vienna (Johannesgasse, 4).

IN the *Geographical Magazine* for January and February will be found Language Maps of India and Further India, including the Indian Archipelago, with accompanying text, by Mr. Robert Cust. Mr. Cust announces that he is collecting materials for a language map of Africa. Such a map already exists in Stanford's "Compendium of Geography—Africa," constructed by Mr. A. H. Keane, who, besides, gives there material for such a map to which, we should think, it would be scarcely possible to add. Is not Mr. Cust's work one of supererogation?

THE *Geographical Magazine* for February contains a curious and interesting autobiography of an Eskimo, Hans Hendrik, who served in the Arctic expeditions of Kane, Hayes, Hall, and Sir George Nares. It was written in Eskimo and translated by Dr. Henry Rink, who writes an introduction.

ETHNOLOGISTS will be interested in a paper in the February number of the *Geographical Magazine*, by Fr. A. de Röepstorff, on the inland tribe of the Great Nicobar. The author concludes that this tribe is certainly not Negrito, the specimen he saw having Mongolian characteristics.

THE mathematical reader will peruse with interest the eleventh number of the *Bulletin* of the Belgian Academy of Sciences (vol. xliv.), where he will find a paper by M. Ghysens, on the determination of volumes and superifices, being the application of an ingenious and new general formula to several difficult and interesting problems; an interesting note by Prof. Catalan, on a new principle of subjective probabilities; and a first paper by Prof. Folie, on the extension of the notion of the anharmonic relation.

THE movements of sediments in the sea it has been common to regard as exclusively an effect of wave-motion. M. Fuchs has recently pointed out that while this is an obvious cause, it is not the only one. Another factor (and one which is probably more powerful in its action), consists in the accumulations which the water undergoes periodically, partly through the flood-tide, partly through winds prevailing on the coasts. Suppose the sea on a coast heaped up ten to thirty feet (and this is not uncommon), the hydrostatic equilibrium must be thereby greatly disturbed, and a current must arise in the depths from the point of greater to that of less pressure, *i.e.*, from the coast to the deeper parts. If a calculation be made of the excess of weight caused by such accumulations of water, such enormous sums are obtained that it is easy to see how the current generated will be strong enough to move not only fine detritus, but large blocks, towards the depths.

THE additions to the Zoological Society's Gardens during the past week include a Banksian Cockatoo (*Calyptorhynchus banksii*) from New South Wales, presented by the Lady Ellesmere; a Common Badger (*Meles taxus*) from Scotland, presented by Lord Saltoun; a Brown Bear (*Ursus arctos*) from North Europe, presented by Mr. J. N. Allen; a Yaguarondi Cat (*Felis yaguarondi*), two Yarrell's Curassows (*Crax yarrelli*), two White-bellied Guans (*Ortalide albiventris*), a White-fronted Guan (*Penelope jacucaca*), a Common Trumpeter (*Psophia crepitans*), a Sun Bittern (*Eurypyga helias*), an American Kestrel (*Tinnunculus sparverius*), all from South America, purchased.

AMERICAN SCIENCE

THE eighth paper of Prof. Loomis' interesting series of "Contributions to Meteorology (*American Journal of Science and Arts* for January, 1878), treats of the origin and development of storms, violent winds, and barometric gradient, the data being obtained from the United States Signal Service observations. Of forty-four different storms recorded between September, 1872, and May, 1874, twenty-one (nearly a half) appear to have originated on or very near the chain of the Rocky Mountains (the others were of various origin). More than two-thirds of the whole originated north of latitude 36°. (We refer to this subject elsewhere.)

This number of the journal also contains some observations by Capt. Belknap, of the *Tuscarora* (during her cruise in the Pacific) proving once more that a cold stratum may exist in the ocean between two warmer ones above and below. The case occurred off the Kurile Islands, between 49° and 52° N. lat. and 158° and 167° E. long. The upper part of the stratum in one place, showing a temperature of 33°·7 F., was only twenty fathoms below the surface, while at ten fathoms below the surface the temperature was 41°. At a depth of 100 fathoms the temperature was 32°; below that curve to a depth of 200 fathoms the range of temperature was from 34°·5 to 38°·7. The width of the cold stratum gradually narrowed to a point in an easterly direction from the coast, or as the edge of the Japan stream was approached. (Several data are furnished regarding the currents in that region.)

An able revision of the atomic weight of antimony has lately been carried out by Mr. Josiah P. Cooke, jun., and the first portion of his paper to the American Academy on the subject is here given in abstract. A new mineral, pyrophosphorite, an anhydrous pyrophosphate of lime from the West Indies, is described by Prof. Shephard, jun. Prof. Rockwood furnishes notices of some recent American earthquakes; and Maria Mitchell, observations on Jupiter and his satellites, with the equatorial telescope at the observatory of Vassar College. Attention may also be called to a summary of the field work of the United States Geological and Geographical Survey of the Territories, under the charge of Dr. Hayden, for the season of 1877. The surveys in Colorado having been completed during the previous year, the parties prosecuted their work in a belt of country lying mainly in the western half of Wyoming, but also embracing adjacent portions of Utah and Idaho. Among other important results, Dr. White has demonstrated the identity of the lignitic series of strata east of the Rocky Mountains in Colorado with the Fort Union group of the Upper Missouri River, and with the great Laramie group of the Green River basin and other portions of the region west of the Rocky Mountains. The botany of the Survey was represented (it is known) by Sir Joseph Hooker and Prof. Asa Gray. Mr. Jackson has visited the strange ruins found in Northern New Mexico and Arizona, and procured the necessary data for plastic representation of the pueblos, or communal town dwellings, of Taos and Acorna, models of which he has constructed. Contact with Europeans has somewhat modified their ancient style of building, but one can readily see that they are constructed after their ancient prototypes, the dwellings of the forgotten people; forgotten, because the builders of the modern structures are as ignorant of the ancient builders as we are ourselves.

The first number of the *American Journal of Mathematics* will be published early this month, with contributions by Prof. Simon Newcomb, Mr. G. W. Hill, Mr. H. T. Eddy, Cincinnati, O., Dr. Guido Weichold, Zittau, Saxony, Prof. Cayley, Mr. H. A. Rowland, Prof. Charles S. Peirce, Prof. Sylvester, and Mr. William E. Story.

We recently announced that the *American Naturalist* has been removed to Philadelphia for publication under the management of Prof. Cope. This, with other new conditions, has given dissatisfaction to a number of the old contributors. This dissatisfaction has taken definite form and is expressed in a circular as follows:—"The undersigned, who have in past years contributed articles and by other means helped to support the *American Naturalist*, protest against the continued use of their names in the same connection under the new conditions advertised in the December number of 1877." The circular is signed by Profs. Agassiz, Gray, Whitney, Hagen, Shaler, Allen, Farlow, Dana, Marsh, Verrill, Newberry, Grote, and Lockwood.

PRIZES OF THE PARIS ACADEMY OF SCIENCES

THE following is a complete list of the prizes awarded by the Academy at its annual meeting, January 28.

The two great prizes in mathematics and physics were not awarded this year.

In mechanics the Poncelet prize was awarded to M. Laguerre for his mathematical works; the Montyon prize to M. Caspari for his work on Chronometers; the Plumey prize to M. Freminville for his improvements in steam-engines; the Fourneyron prize to M. Mallet for his tramway engine.

In astronomy the Lalande prize was given to Prof. Asaph Hall, the discoverer of the satellites of Mars; the Vaillant prize to M. Schuloff for his method of detecting the small planets: the Valz prizes to MM. Paul and Prosper Henry for their star maps.

In physics the Lacaze prize was awarded to M. A. Cornu for his researches on the determination of the rate of light.

In chemistry the Jecker prize was awarded to M. A. Houzeau for his researches on the production of ozone; the Lacaze prize to M. Troost for his many valuable chemical researches.

In botany the Barbier prize was divided between M. Galippe for his toxicological studies on cantharides, MM. Lepage and Patrouillard for their services to medicine and pharmacy, and M. Manouvriez for various physiological researches. The Desmazières prize was divided in part between Dr. Quélet for his work on the fungi of the Jura and the Vosges, and M. Bagnis for his memoir on the puccinia. From the Bordin prize an encouragement of 1,000 francs was awarded to M. Charles Eugène Bertram for his work on the lycopodiaceæ; another Bordin prize was awarded to the same botanist for his work in connection with angiosperms and gymnosperms.

In anatomy and physiology the Shore prize was awarded to M. Jousset de Bellesme for his researches on the physiology of insects.

Among prizes in medicine and surgery, one of 2,500 francs was given to Prof. Hannover, of Copenhagen, for his work on the retina of man and the vertebrates; 1,500 francs to Dr. Topinard for his work on anthropology.

In physiology the Montyon prize was divided between Prof. Ferrier and MM. Carville and Duret. The Lacaze prize was given to M. Dareste for his researches on the artificial production of monstrosities.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Smith's Prizes have been adjudged as follows:—First prize, John Edward Aloysius Steggall, B.A., Trinity, second wrangler, 1878; second prize, Christopher Graham, B.A., Gonville and Caius College, third wrangler, 1878. By this award it will be seen that the senior wrangler has failed to secure either of the Smith prizes, an unusual circumstance, which has only occurred seven times since the foundation of the prizes by Dr. Smith in 1769, viz., in 1770, 1830, 1859, 1867, 1874, 1875, and again this year.

EDINBURGH.—The Falconer Memorial Fellowship in Palæontology and Geology, of the annual value of about 100*l.*, tenable for two years (and, under certain conditions, for a longer period), is now vacant, and is open for competition by graduates in Science or Medicine of the University, of not more than three years' standing at the time of the competition. Names of candidates must be sent, on or before the 1st of April, to the Secretary of the University, from whom further details may be obtained.

The Shaw Fellowship in Mental Philosophy, of the annual value of about 170*l.*, tenable for five years, will be open to competition in December next by graduates in arts of either of the four Scottish Universities, of not more than five years' standing at the time of the competition, and by all students of the said Scottish Universities, who, although they have not graduated in arts, have successfully passed all the examinations necessary for graduation in arts within the period of five years before the time of the competition. Candidates must give their names and addresses to the Secretary of the University before December 1.

PRUSSIA.—The ten Prussian universities cost yearly 7,146,000 marks (357,000*l.*), of which sum about two-thirds is contributed directly by the State. This amount is divided as follows:—Berlin, 1,334,700 marks; Bonn, 712,500; Königsberg, 668,600; Breslau, 620,300; Kiel, 478,800; Marburg, 430,400; Halle, 368,800; Göttingen, 268,600; Greifswald, 135,600, and Münster, 102,500. The Saxon Government has difficulty in inducing its parliament to bestow its usual annual grant of 700,000 marks on the University of Leipzig, the argument being advanced that only one-third of the students were natives of the kingdom.

FRANCE.—The new Ministry is making rapid strides in the direction of general education. In a law lately laid before the Chamber of Deputies, we notice an appropriation of 120,000,000 francs, which is intended to serve for the erection or purchase of over 27,000 new school-houses, as well as their equipment.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 12, 1877.—On the laws according to which gases spread in liquid, viscous, and solid bodies, by M. v. Wroblewski.—On the galvanic resistance of selenium, by M. Forssmann.—On the relation of the electric conductivity of selenium to heat and light, by M. W. Siemens.—Influence of light on the electric resistance of metals, by M. Hanseman.—On the significance of polarisation for the electric behaviour of liquids, by M. Herwig.—On a mode of inference employed by M. Clausius in the electrodynamic theory, by M. Zöllner.—Supplement to a paradox of the mechanical theory of heat, by M. Ritter.—On the Crookes's radiometer, by M. Hankel.—On the perception of colours, by M. Weinhold.—On the composition of æschynite and samarskite, by M. Rammelsberg.—On the inventor of the plate of the air-pump, by M. Gerland.—Supplement to "Studies on Chemical Volumes," by M. Ostwald.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xi. fasc. xvii.—Memoir of Prof. Giuseppe Ferrari.—Reports of the classes, announcement of prizes, &c.

Fasc. xviii.—Experiments with regard to the action of heat on the radiometer, by M. Hajech.—Researches on differential equations, by M. Casorati.—On seismic movements in the valley of Chiana and their influence on the hydrographic condition of the valley of the Tiber, by M. Verri.—On a peculiar horny growth, by M. Sangalli.

Journal de Physique, December.—Telephones, by M. Niaudet.—On a new apparatus for measuring the frequency of periodic movements, by M. Marey.—Continuity of the liquid and the gaseous state of matter, by M. Bouty.—Study on the formation of the negative photographic image, by M. Lermontoff.

Morphologisches Jahrbuch, vol. iii., Part 4.—R. Wiedersheim, on the cranial skeleton of Urodela, ninety pages, four plates, dealing with Siredon, Amblystoma, Salamandra, Chioglossa, Triton, and the Salamandridæ generally.—W. Salensky, on the budding of Salpæ, fifty-four pages, 3 plates.—W. Rauber, on the last spinal nerves and ganglia.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, January 9.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—Ephraim Brunt, T. W. Cowan, and Henry Fox were elected Fellows of the Society.—The following communications were read:—On the great flat lode south of Redruth and Camborne, by Dr. C. Le Neve Foster, B.A.—On some tin-mines in the parish of Wendron, Cornwall, by Dr. C. Le Neve Foster, B.A.—On some of the stockworks of Cornwall, by Dr. C. Le Neve Foster, B.A.—The precarboniferous rocks of Charnwood Forest, Part II., by the Rev. E. Hill, F.G.S., Fellow and Tutor, and the Rev. T. G. Bonney, F.G.S., Fellow and late Tutor of St. John's College, Cambridge. The authors described the result of the microscopic examination of a considerable series of the clastic rocks of Charnwood. Many of these, even among the finer beds, prove to be of pyroclastic origin. The coarser are generally composed of a ground mass of pulverised felspar, with viridite and some iron peroxide, full of larger fragments of felspar crystals (generally both of orthoclase and plagioclase) and lapilli. The structure of these is often distinct, some are certainly andesites, others some kind of trachyte; slaty fragments are also present, and occasional grains of quartz. The authors express their opinion that all the larger felspar crystals, and most, if not all, the quartz grains, are of clastic origin, even in the more highly altered varieties. Some of the

larger fragments in the breccias were examined, and referred in part to devitrified trachytes not very rich in silica. The igneous rocks were then described. The syenites of the southern and northern districts were shown probably to belong to one system of intrusion. The hornblendic granite of the Quornden district was also described, and the microscopic structure of the different varieties of it and the above investigated. A number of igneous rocks generally forming dykes in these was described; some appear to be altered basalts, others andesites, one is a felsite, another a diorite. A group of outlying igneous rocks in the vicinity of Narborough was described. Of these, one is a quartz feltsite with some hornblende; another varies between this and a quartziferous syenite; the rest are syenites, and one contains so much plagioclase as to be almost a diorite. One of the above, near Enderby, is seen to be distinctly intrusive in an altered slaty rock, which the authors have no doubt belongs to the Forest series. This discovery proves the igneous character of these rocks also, and extends the area of the slaty series five miles further south than was previously known. A section was devoted to the faults of the Forest region. Here the principal fault runs along the anticlinal axis, with a downthrow on its eastern side which diminishes from 2,500 feet at the north end to 500 feet at the south end. East of this the beds seem undisturbed, but on the west they are shattered by many faults, whose course cannot be traced. These are most numerous near Whitwick. The anticlinal fault is pre-carboniferous. In conclusion, the age of the clastic and of the igneous rocks was discussed. The authors inclined to the opinion that the former are of the same age as the Borrowdale series of the Lake district (lower Silurian), but admitted that the recent discovery of agglomerates in the pre-Cambrian rocks of Wales, and in the probably pre-Cambrian ridges of the Wrekin district, weakens the arguments for this correlation. They do not think that there is any reason for supposing them Cambrian. If the Charnwood series is lower Silurian, they think it most probable that the syenites and the Quornden granite were intruded in some part of the old red sandstone period, and that the later dykes were very probably post-carboniferous but pre-triassic.

Meteorological Society, January 16.—Mr. H. S. Eaton, M.A., president, in the chair.—The Council, in their Report, express their gratification at the increase in the number of the Fellows and stations of the Society, the greater size of the *Quarterly Journal*, and the higher value placed on it by foreign scientific societies, the augmentation of the library, and the addition to the sum hitherto contributed by the Meteorological Council, as well as at other evidences of vigour and progress manifested during the year. The number of Fellows now amounts to 417. The president then delivered his address:—During his tenure of office the alliance between the Meteorological Council and the Society had been further cemented, the Society supplying the Government with certain statistics, and getting some assistance from the Council in return. This arrangement had been completely successful, and the president considered it calculated to foster the growth of climatic meteorology under the auspices of the Society, and likely to remove any jealousy on the part of the public towards a governmental department so peculiarly constituted as the Meteorological Council. After criticising some of the work undertaken by the last-mentioned body, Mr. Eaton exhibited curves of the results of the hourly observations of the barometer and thermometer for the year 1876 at Valentia, Armagh, Glasgow, Aberdeen, Falmouth, Stonyhurst, and Kew, these being the stations established in 1868 for determining the meteorological constants of the British Isles. The curves showing the combined diurnal and semi-diurnal variation of atmospheric pressure might be referred to one of two distinct types. In one of them the minimum of pressure was most pronounced in the morning, in the other in the afternoon. The former type was found at the maritime stations of Valencia and Falmouth, the latter at inland stations such as Kew. The diurnal range of the temperature of the air was closely related to the pressure. It was least at the maritime stations, reaching only 4°·8 at Falmouth, and attaining a maximum of 9°·3 at Kew.—The following gentlemen were elected Officers and Council for the current year:—President: Charles Greaves, M.Inst.C.E., F.G.S. Vice-Presidents: Henry Storks Eaton, M.A., James Park Harrison, M.A., Robert James Mann, M.D., F.R.A.S., Charles Vincent Walker, F.R.S. Treasurer: Henry Perigal, F.R.A.S. Trustees: Sir Antonio Brady, F.G.S., Stephen William Silver, F.R.G.S. Secretaries: George James Symons, John W. Tripe, M.D. Foreign Secretary: Robert H. Scott, M.A., F.R.S. Council: Hon. Ralph Abercromby, Arthur Brewin, F.R.A.S., Charles Brooke, F.R.S., Edward Ernest Dymond, William Ellis, F.R.A.S., Rogers Field, B.A., M.Inst.C.E., John Knox Laughton, F.R.A.S., Rev. William Clement Ley, M.A., Richard Strachan, Henry Samuel Tabor, Capt. Henry Toynbee, F.R.A.S., George Mathews Whipple, B.Sc.—A resolution was passed to the effect that ladies be admissible as Fellows of the Society.

Physical Society, January 19.—Prof. G. C. Foster, president in the chair.—The following were elected Members of the Society:—J. Angell, Lieut. G. S. Clarke, R.E., T. F. Iselin, M.A., J. W. Russell, M.A.—Mr. W. H. Preece read a paper on some physical points connected with the telephone. This instrument may be employed both as a source of a new kind of current and as the detector of currents which are incapable of influencing the galvanometer. It shows that the form and duration of Faraday's magneto-electric currents are dependent on the rate and duration of motion of the lines of force producing them, and that the currents produced by the alteration of a magnetic field vary in strength with the rate of alteration of that field; and further, that the infinitely small and possibly only molecular movement of the iron plate is sufficient to occasion the requisite motion of the lines of force. He pointed out that the telephone explodes the notion that iron takes time to be magnetised and de-magnetised. Mr. R. S. Brough has calculated that the strongest current employed in a telephone is $\frac{1}{1000000000}$th of the C. G. S. unit. Mr. Preece explained that the dimensions of the coil and plate depend on the strength of the magnet, but the former should always consist of fine wire and be made as flat and thin as possible. The adjustment of the position of the magnet (as near as possible to the plate without touching) is easily effected by sounding a vowel sound *ah* or *o* clearly and loudly; a jar is heard when they are too near together. After briefly enumerating the attempts which have been made to improve the instrument, he mentioned the various purposes to which it can be applied. In addition to being useful in the lecture room, in conjunction with several well-known forms of apparatus, it forms an excellent detector in a Wheatstone bridge for testing short lengths of wire, and condensers can be adjusted by its means with great accuracy. M. Niaudet has shown, by employing a doubly wound coil, that it can be used to detect currents from doubtful sources of electricity, and it is excellent as a means of testing leaky insulators. Among the facts already proved by the telephone may be mentioned the existence of currents due to induction in wires contiguous to wires carrying currents, even when these are near each other for only a short distance. Mr. Preece finds that if the telephone wire be inclosed in a conducting sheath which is in connection with the earth, all effects of electric induction are avoided; and further, if the sheath be of iron, magnetic induction also is avoided, and the telephone acts perfectly. A great number of experiments on the use of the instrument on telegraphic lines were then described, from which it appears that conversation can be carried on through 100 miles of submarine cable, or 200 miles of a single wire without difficulty, with the instrument as now constructed. The leakage occurring on pole-lines is fatal to its use in wet weather, for distances beyond five miles. An interesting series of telephones was exhibited, and by means of one of very large dimensions Mr. Preece showed that the currents produced by pressing the centre of the plate sensibly affect a Thomson galvanometer, and that the motion of the needle ceases in a remarkably instantaneous manner as soon as the pressure is removed, a necessary condition in order that the receiving-plate should accurately reproduce the motions of the sending-plate. In the discussion which followed, Mr. R. Sabine suggested that the failure of all attempts at improving the instrument by increasing its dimensions might be due to the *damping* action of the permanent magnet on the plate, the strain on it being proportional to the size of magnet and rendering it less sensitive to the sonorous waves. Mr. Coffin pointed out how interesting it would be if, instead of employing a receiving-instrument, the currents could be communicated directly to the auditory nerves, and Prof. Adams explained the relation subsisting between the character of the vibrations of the disc and the character of the electric currents to which they give rise.—Dr. Lodge described a simple form of apparatus for determining the thermal conductivity of rare substances, such as crystals, which cannot be obtained in slabs or rods. It consists of two small tin cans with a copper arm about eight inches long projecting horizontally from each, the external ends being clean and flat. They are

placed in a straight line with the crystal between them, and held together by a slight horizontal pressure. Holes are drilled in the copper rods for thermometers, and the curves of temperature being given by these, that for the intermediate crystal can be at once calculated.

Victoria (Philosophical) Institute, January 21.—Prof. Lias, of St. David's College, read a paper on Matthew Arnold and modern culture.

February 4.—The Right Reverend Bishop Cotterill read a paper upon scientific thought and religious belief.

Institution of Civil Engineers, January 22.—Mr. Bateman, president, in the chair.—The paper read was on some recent improvements in dynamo-electric apparatus, by Dr. Higgs, Assoc. Inst. C.E., and Mr. Brittle, Assoc. Inst. C.E.

MANCHESTER

Literary and Philosophical Society, December 11, 1877.—Mr. E. W. Binney, F.R.S., president, in the chair.—Note on the daguerreotype portrait taken of the late Dr. Dalton, by J. B. Dancer, F.R.A.S.—Note on metallic niobium and a new niobium chloride, by Prof. H. E. Roscoe, F.R.S.—On the retention of saline impurities by hydrated ferric oxide, by Mr. Charles Frederick Cross, Dalton Scholar in the Owens College. Communicated by Prof. H. E. Roscoe, F.R.S.

December 26.—Mr. E. W. Binney, F.R.S., president, in the chair.—Notice of a large boulder stone at Old Trafford, Manchester, by E. W. Binney, F.R.S.—On the geometrical representation of the equation of the second degree, by Charles Chambers, F.R.S., Superintendent of the Colaba Observatory, Bombay. Communicated by J. A. Bennion, F.R.A.S.

EDINBURGH

Chemical Society, January 16.—Mr. W. Inglis Clark, B.Sc., vice-president, in the chair.—A paper was read by Mr. John Gibson, Ph.D., F.R.S.E., on yttrium and erbium, being the second part of an historical sketch of the rarer elements.

January 30.—Mr. Newton Burns presiding.—Papers were read by Mr. G. Carr Robinson, F.R.S.E., on the solid fatty acids of cocoa-nut oil, and by Messrs. Robinson and Thomson on the composition of gases from lime-kilns.

PHILADELPHIA

Academy of Natural Sciences, July 3.—Prof. G. A. König, on protovermiculite, a new micaceous mineral from Arkansas, $R'_3R^{vi}Si^{iv}{}_3O'_{12}+H_2O$, related to jefferisite and colsageite.

July 24.—Mr. J. A. Ryder, on colour variation in mammals. The distribution of colour in wild and domestic animals was compared, showing that bilateral symmetry of colouring is interfered with in some way by domestication, wild animals almost invariably being symmetrically coloured.

July 31.—Dr. Rothrock, on the poisonous properties of the Leguminosæ.

August 14.—Prof. G. A. König, on strengite, from Virginia. This mineral, $Fe_2P_2O_8+4H_2O$, was discovered in cavities in dufrenite.

August 28.—Dr. D. J. Jordan and W. S. Brayton, on Lagochila, a new genus of catostomoid fishes, known in Georgia as the Hare-lip Sucker.

WELLINGTON

Philosophical Society, August 4, 1877.—W. T. L. Travers, F.L.S., M.H.R., president, in the chair.—Dr. Hector drew attention to several interesting additions to the museum, which were arranged on the table. Among the most important was a handsome bird from New Guinea, the *Goura victoriæ*.—Mr. Kirk also called attention to a log of black maire, a species of olive (*Olea apitita*), sent by Mr. Elliotte, of the Pakuratahi, which, on account of its great hardness, is much used as blocks and cogs in machinery.—Capt. Edwin read a letter from Mr. Rawson, on the reciprocity of seasons, the character of the seasons in Europe being followed by a similar season in Australia and New Zealand. Mr. Carruthers thought that even in New Zealand the seasons did not agree; and Dr. Hector said it would be necessary to fix upon the one place for comparison, as seasons were not uniform, a moist season on the east coast being frequently a dry season on the west coast. Dr. Newman considered that the seasons were affected all over the world by sun-spots.—Mr. McKay then read a paper on gold found in the Mackenzie district of Canterbury; on which subject Dr. Hector added some interesting information regarding the occurrence of gold generally in that district, and pointing out that Mr. McKay's observation that the gold and associated quartz were found only in the last formed moraines and alluviums, confirmed his theory that the retirement of the glaciers was chiefly due to the erosion of the mountains.

VIENNA

Imperial Academy of Sciences, December 13, 1877.—On the present state of the water question, by M. Wex.—On the anatomy of the African elephant, by M. Mojsisovics.—The electrical after-currents of transversally magnetised iron bars, by M. Streintz.

December 20.—The protoplasm of the pea, by M. Tangl.—On a new apparatus for direct volumetric determination of the moisture of the air, by M. Schwackhofer.—Elementary deduction of the complete formula for determination of the tone of vibration of a mathematical pendulum, by M. Pscheidl.—Contribution to knowledge of cupric chloride, by M. Rosenfeld.—On the air-pressure at Vienna, with supplemental remarks on the temperature of Vienna, by M. Hann.

GÖTTINGEN

Royal Academy of Sciences, November 3, 1877.—Attempt at a theory of electric separation through friction, by M. Riecke.

December 1.—Report of the Secretary (126th anniversary).—Obituary notice of von Baer.—Announcement of subjects for prize competition, &c.—On the formation of the volcano of Fuego in Guatemala, and account of an ascent of it, by M. von Seebach.—On the origin of language, by M. Benfey.

December 26, 1877.—New geometrical and dynamical constants of the earth, by M. Listing.

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